“My imagination makes me human and makes me a fool; it gives me all the world and exiles me from it.”

—URSULA K. LE GUIN

Behavioral Science in the Backcountry

The Decades-Long Quest to Overcome “The Human Factor” in Avalanche Deaths

By Greg Rosalsky

On a stormy Sunday in February 1995, 37-year-old Steve Carruthers strapped on his skis and headed into the Wasatch Mountains near Salt Lake City, Utah. It had dumped almost two feet of snow that weekend, and Carruthers and two friends wanted to ski powder in the untamed wilderness of the backcountry. The Utah Avalanche Center’s advisory warned there was a serious danger of avalanches that day. The new snow, it cautioned, had fallen on a slippery crust of ice, and steeper slopes could slide. But these skiers were seasoned veterans, and they believed they could avoid trouble.

The three skiers cut through a thick morning fog, gliding past the evergreen conifers and leafless aspens of Big Cottonwood Canyon and began climbing the southeast face of a 10,246-foot peak called Gobblers Knob. They all had skied the area countless times. They all had

beacons, shovels, and probes, the standard safety equipment for finding and extricating victims buried by avalanches. And they all knew to avoid slopes steeper than 30 degrees, the crucial threshold when slopes start becoming steep enough to slide.

Despite their experience, equipment, and training, however, the trio failed to recognize an obvious hazard. While the shallow, tree-covered slope they were ascending was not steep enough to avalanche, their route crossed under steeper terrain that could. And at about noon, the party seems to have remotely triggered an avalanche on an overhead slope. The face of the upper mountain shattered like a giant pane of glass. Within seconds, a broken slab that had been about 150 feet wide and two feet deep came rumbling towards them at around 50 miles per hour. All three were swept down the mountain by its mighty force.

The skiers' screams echoed through the canyon, and another party of skiers in the distance came rushing to help. When they arrived a half hour later, they discovered two dazed and injured men. One had only minor injuries. The other was in shock from a broken femur and risked dying of hypothermia. But they were both lucky because they had only been partially buried. They had been able to free their heads and breathe. This bought them enough time to be rescued.

Carruthers wasn't so lucky. The avalanche had rammed him into an aspen tree and buried him under two feet of snow. When the rescue party finally dug Carruthers out, they found him lifeless, with his jacket pushed over his head. He had broken ribs, a broken pelvis, and had likely asphyxiated under the frozen debris. The rescuers tried but couldn't resuscitate him. Carruthers would not be coming home that night to his wife and four-year-old daughter.

As tragic as this story is, it's made even more tragic by the fact that the story repeats itself again and again—not just in mountains all over the world but on the very same mountain where Carruthers met his fate.

In 2003, veteran backcountry skier Alan Davis died on Gobblers Knob in an avalanche that buried him under four feet of snow.

In 2007, Norwegian skier Vegard Lund, who had come to Salt Lake City to study at the University of Utah, died after an avalanche on Gobblers Knob swept him into a grove of trees.

In 2016, 49-year-old skier Douglas Green triggered an avalanche that buried him deep in a gully, killing him.

And just last year, on a peak right next to Gobblers Knob, four skiers in their twenties—Sarah Moughamian, Louis Holian, Thomas Louis Steinbrecher, and Stephanie Hopkins—all died after getting caught in a monstrous slide that was 1,000 feet wide.

In most of these cases, the skiers had significant experience, formal avalanche training, and died on days when the Utah Avalanche Center had warned of considerable avalanche danger.

As is common in the aftermath of avalanche fatalities, when Steve Carruthers died, some in his community wrote his death off, concluding he was just another careless adrenaline junkie who failed to heed warnings. But Ian McCammon knew Carruthers. They had climbed and skied together over the years. Just a couple weeks before Carruthers lost his life, McCammon bumped into him at the Utah ski resort Alta. It had been a few years since they'd spent time together, and while riding the ski lift, they reminisced and caught up.

McCammon had moved to Salt Lake City to get his Ph.D. in mechanical engineering at the University of Utah, and he met Carruthers shortly after when he got involved in the local backcountry scene. When McCammon first started skiing and climbing with Carruthers, he came to see his friend as a bit of a daredevil. But, as a lift whisked them up the mountain, Carruthers reflected on his life and told McCammon something he'd never forget.

"He told me how he had a daughter now, and how he wasn't the risk taker he used to be," McCammon says. Carruthers said that his days of heading into the mountains and making sketchy choices were over. He was a family man now, and while he still loved exploring the backcountry, his paternal instinct to always come home to his wife and daughter had greatly diminished his tolerance for risk. "And that really sat with me, and it echoed weeks later when I heard Steve died."

When McCammon got news of Carruthers's death, it really unsettled him. He was, of course, devastated to lose a friend, and he was devastated for Carruthers's family. But he was also flabbergasted by how the accident could have happened. Carruthers was an experienced backcountry skier. He had a deep knowledge of the Wasatch Mountains and the dangers of avalanches. And he had so much to live for. McCammon really believed him when he said that he was not willing to take stupid risks.

Agonizing over the tragedy, McCammon pored over the Utah Avalanche Center's accident report. He knew hindsight is twenty-twenty, but he could also see all kinds of obvious warning signs that the trio had ventured into treacherous terrain that day. The avalanche warning. The fresh snow on the ground. The topography of the area they were climbing. People had died on that same mountain before. What was going on in his friend's head as he ascended Gobblers Knob?

An avalanche may seem like an earthquake or a lightning strike or a shark attack, a random act of nature that is almost impossible to predict. But avalanche scientists have made incredible progress forecasting when and where they are most likely to occur. In most instances, the avalanches that kill people don't just happen. They are triggered. And in about 90 percent of accidents, they are triggered by the victim themself or someone in the victim's party. Most of the time, there are obvious clues that danger lurks in the snowpack.

McCammon ruminated on whether he could make similar mistakes, and he began reevaluating his whole perspective on avalanche accidents. "Up until that point, I really believed that having a good education on avalanche safety and lots of experience would be sufficient to avoid most dangers, especially when it comes to someone like Steve who had so much to live for," McCammon says. In other words, he had believed people were rational and all backcountry goers needed to stay safe was the right information. Now he wasn't so sure. "Steve's death had a profound effect on me."

Having just begun teaching avalanche safety classes at the National Outdoor Leadership School in his spare time, McCammon began to question whether he and the broader outdoor community were preparing people well enough to stay safe. Not just when it comes to teaching people about the signs of avalanche danger—but preparing them to recognize how flaws in their decision-making can lead them to ignore those signs of danger.

Although he had focused his undergraduate education on physical sciences, McCammon had encountered ideas from psychology while getting his Ph.D. in mechanical engineering. His focus was robotics and developing machines capable of making decisions, which piqued his interest in the basic psychology of decision-making. During his reading, he stumbled upon the idea that humans often rely on "heuristics," or simple rules of thumb, to quickly navigate the complexities of the world when they don't take the time to sit and think.

The concept of heuristics was developed by psychologists Daniel Kahneman and Amos Tversky back in the 1970s. It's had a huge influence on all sorts of fields. One example of a heuristic they identified is known as availability, which is when our judgments are influenced by "the ease with which instances or occurrences can be brought to mind." For instance, if you read news reports that say there haven't been any avalanche fatalities this season, that may stick in your head and influence you to underestimate the probability of snow slides, whether or not conditions change.

The snow-covered backcountry is a difficult place for human psychology.

Heuristics create a sort of autopilot for our brains, and, most of the time, they work remarkably well. But this autopilot system can steer us in directions that, in a rational state of mind, we would never want to go.

In the aftermath of Carruthers's death, McCammon dove into the psychology literature and began exploring theories and evidence for how heuristics affect human decisions. He was particularly interested in research by the psychologist Robert Cialdini on how advertising firms, cult leaders, and other antagonists exploit our heuristics and steer us where they want us to go. But the antagonist McCammon now set his sights on wasn't a person or a business. It was something lurking under the snowy face of a mountain, an invisible layer within the snowpack—"a weak layer"—which is the most common contributor to avalanche deaths.

"The mountain may not be deliberately trying to fool you," McCammon says. But lurking beneath its beautiful and tantalizing slopes is something that can. McCammon began to use the term "heuristic traps" for the faulty processes of the mind that can blind backcountry travelers to obvious dangers and lure them into peril in the mountains. While there were avalanche experts before McCammon who had recognized that human error could play a role in backcountry accidents, the avalanche community lacked rigorous research showing the severity of the problem and effective methods to try and combat it.

And so, inspired by his friend's death, McCammon began leading a double professional life. By day, he continued his career as a mechanical engineer, developing robots and aerospace systems for organizations like NASA and the Department of Defense. But at night and on weekends and days off, he began the mostly unpaid work of doing research, publishing papers, and developing tools that would revolutionize the avalanche world.

Bruce Tremper's path to becoming one of the world's foremost experts on avalanches began with an avalanche. Raised in western Montana, Tremper moved to Bozeman after undergrad and began working at Bridger Bowl Ski Area. His first job was building ski lifts. On a blustery day in November 1978, he was out alone tightening bolts on lift towers. It had snowed a foot the day before, and wind gusts were loading leeward slopes with extra snow.

After Tremper finished tightening bolts on one lift tower, he needed to reach the next one. The most direct route between the two towers crossed a 30-foot-wide couloir, a steep gully in the mountainside. He knew the couloir was avalanche terrain, so he planned to avoid it. Instead, he would climb a short distance up the mountain and make it to a ridge, circumnavigating the couloir with a safer path to the tower. But that morning, Tremper had forgotten sticky climbing skins for his skis, which backcountry skiers use to ascend in the snow, so he had to make the climb on foot. The chest-deep snow battled him every step of the way, and it quickly became clear that climbing would take too much time and effort.

Tremper, however, was an experienced ski racer. He was young. He was cocky. And he decided he could instead "ski cut" the couloir, zipping across the slope at a 45-degree angle, fast enough to outrun an avalanche if the slope did end up sliding. But as he tried to cut across the slope, he realized he had made a horrible miscalculation. He heard a muffled *thunk*, and, he says, it was like someone yanked a rug from underneath him.

The avalanche took him on a ride down the couloir before slamming him into a tiny tree. He quickly grasped the tree and held on for dear life, as a mighty river of snow moving at highway speeds flowed around him. The tree broke and he continued down the slope, gasping for air as he fought to swim above the surface. He began to brace for the worst as he submerged into the snowy torrent. But then, all of a sudden, the ferocious river stopped. Tremper's lower body was stuck in avalanche debris, but his head and arms were free. He was able to slowly chip himself out with the shovel he had in his backpack. The resort ended up naming the couloir "Tremper's," in honor of the lucky survivor.

"I wanted to learn everything I could about avalanches after that," Tremper says. "That avalanche changed my life."

Tremper went on to study avalanches at Montana State University, earning a master's degree in geology in the process. Meanwhile, he continued working at Bridger Bowl, becoming a ski patroller tasked with avalanche control. On mornings before the ski resort opened, he would strap on a pack filled with explosives and head to the resort's black diamond and double–black diamond runs, chucking bombs at the avalanche-prone slopes to clear them of deadly threats to resort guests. "I got to do all these trial-and-error experiments—and I learned so much about avalanches," he says.

After grad school and a stint as the avalanche director for Big Sky Resort, Tremper got a dream job as a backcountry avalanche forecaster at the Alaska Avalanche Forecast Center. There he got to learn from the center's head honchos, Jill Fredston and Doug Fesler, a married couple who were on their way to becoming world-renowned avalanche experts. Together they pioneered methods to teach people about avalanches that are still used today.

Before his time in Alaska, Tremper hadn't done much thinking about how humans think—and whether problems with our thinking could kill people in the backcountry. But Fredston and Fesler had spent a long time witnessing carnage in the mountains of Alaska. They saw incident after incident of skiers and snowboarders making the same stupid decisions in the face of overwhelming signs of danger. To explain why so many backcountry goers behaved like lemmings jumping into a dark abyss, Fredston and Fesler began incubating ideas that have come to be known in the avalanche community as "the human factor."

"Jill and Doug weren't social scientists, and research on the human factor was still in its infancy at the time," Tremper says. But Fredston and Fesler came to believe that there were unconscious errors in judgment that routinely led people to their death in mountainous hinterlands. They even started giving their own folksy names to the mistakes they observed, some of which behavioral scientists would call heuristics and biases. Fredston and Fesler called the tendency to blindly follow others "the sheep's syndrome." They called the rush to get the first powder tracks on a slope "the lion's syndrome."

But, Tremper says, at first he didn't buy the idea that flaws in human cognition systematically led adventurers to their peril. "I was trained in the physical sciences," he says. He saw the problem of avalanches through the lens of physics and topography and snow science. He had assumed that most deaths could be prevented by simply educating recreationists about snow dynamics. "When I was younger and coming out of graduate school, I thought people were rational."

It's hard to blame him. Tremper was like a lot of people back then, even those trained in social science. At that point, in the 1980s, most economists and many other social scientists had fallen head over heels for rational choice theory, which embraced mathematical models of human behavior in which people were perfectly rational. The implication of these models was that all people needed was information and resources, and they would always make the best choices for themselves.

But Tremper's new job as a backcountry avalanche forecaster entailed investigating avalanche accidents. And data point after data point slowly brought a startling reality of the backcountry into light. It was a reality in which skiers and snowboarders with ample avalanche training routinely died in circumstances that could have been easily predicted and avoided. Tremper, like Fredston and Fesler before him, began to have nagging doubts about the rationality of humankind. However, it wasn't until the death of his friend Mark Yates that he became fully converted.

By then, Tremper had become the director of the Utah Avalanche Center, which is based in Salt Lake City. He had hired Yates as the avalanche forecaster for the Moab area, which is on the eastern side of the state. Yates had been pretty inexperienced in avalanche forecasting at the time, but he was a Moab local and expert skier with tons of backcountry experience in the La Sal Mountains, a majestic range of snow-capped peaks that towers high above the red rocks of the Moab desert. Tremper believed Yates could grow into becoming an effective avalanche forecaster for the region.

In the winter of 1992, the Moab area spent weeks in a snow drought. In early-to-mid February, it finally began snowing again. And on February 12, the skies cleared and a couple feet of fresh snow beckoned Yates and five other skiers into the La Sal Mountains. "They were thirsty for powder," Tremper says.

The group began the day climbing a low-angle, avalanche-safe ridge up to a subsummit

known as Pre-Laurel Peak. Standing at about 11,000 feet, they gazed upon an expansive winterscape glimmering in the sun. Yates was in high spirits, intoxicated by the conditions. He insisted they ski down the south face of the peak and then head into Talking Mountain Cirque, a gorgeous, upper-elevation bowl that looks like a humongous white amphitheater.

At the base of Talking Mountain Cirque, the slope is gentle, well below the 30-degree threshold where terrain can avalanche. But above that are three steep faces that can—and often do—avalanche. It was absolutely dangerous to go there in the snow conditions the skiers faced that day.

"They thought they were okay with the slope angle they were on," Tremper says. "But I know that Mark knew that you can pull these things down from below—that these collapses can propagate uphill. And when that collapse reaches terrain steep enough to slide, then it'll slide down on top of you. I mean, he *knew* that."

Two members of the group had taken an avalanche class from Tremper only weeks before. The survivors recalled these two voicing concerns about heading into Talking Mountain Cirque. They said it was a dangerous and stupid destination when there seemed to be instability in the snowpack. But Yates was the Moab avalanche forecaster. He was the alpha dog. And he kept insisting they would be okay; that they would keep traveling on gentle slopes and stay safe.

The group ultimately deferred to Yates. And, as they traveled to the cirque, they ignored all kinds of obvious clues of danger on the way. They saw evidence that a slope in the distance had already experienced a natural avalanche. They saw the snow crack underneath their skis and heard *whumpf* sounds. But, somehow, they "just kept going higher and higher into the bowl," Tremper says. "And, interestingly enough, the people who had been the most vocal that it was dangerous—they were the ones out in front, breaking trail when the whole thing came down."

The survivors recounted stopping at the precipice where the bowl started getting steep enough to slide. There, several members of the group again raised concerns about what they were doing. But it was already too late. As they stopped to talk about what to do next, they felt the snow collapse under their feet. And they heard another *whumpf*. But this telltale sound of avalanche danger was louder than the ones they heard before, reverberating through the entire amphitheater. The group looked up and saw the upper slopes all sliding. They had triggered three avalanches on three separate faces of the cirque—and two of the slides formed a V shape and were heading right towards them. They began yelling.

The avalanches completely buried and killed four of the six skiers—including Yates. It was the single most fatal avalanche accident in recorded Utah history. That is, until just this past season, when Sarah Moughamian, Louis Holian, Thomas Louis Steinbrecher, and Stephanie Hopkins all died in the Wasatch Range, near Gobblers Knob.

The Talking Mountain Cirque accident was a huge deal in Utah. Not just because it's rare for that many skiers to die at once, but because Yates was the local avalanche forecaster, and he had been traveling with a group of expert skiers who had avalanche training. It was clear they should have known better.

At the time of the accident, Tremper was actually overseas, in Japan. He had been contracted by the Japanese government to help launch an avalanche center. This was before

Bruce Tremper helped lead the movement to incorporate "human factors" into avalanche safety training.

ORIGINAL PHOTO: Bruce Tremper.

In the aftermath of Carruthers's death, McCammon began a quest to understand the cognitive errors that could lead people to their death in the backcountry.

smartphones and widespread use of the internet, so Tremper didn't hear about the accident until he returned. And when he did, the news jolted him. He began poring over the details of the accident and hearing the play-by-play from survivors.

"With that Mark Yates accident—all the things happened that Jill Fredston and Doug Fesler told me about," Tremper says. "There were all these human factors going on."

Using the terminology developed by Fredston and Fesler, Tremper could see evidence of "the lion's syndrome," or the race to get fresh powder. He could see the "sheep syndrome" when the group blindly followed Yates into trouble. He could see that Yates had been crowned as the group's expert and that the group deferred to his judgment, as flawed as it was. And Tremper could see what social scientists call confirmation bias in the group's over willingness to disregard signs of danger and confirm to themselves that their chosen route was safe.

From that point on, Tremper's view of the human factor completely changed—and he got serious about warning the avalanche community about it. "I realized that we need to start talking about human factors in our avalanche classes, addressing them specifically," Tremper says.

Within two years, he joined Jill Fredston in presenting a paper about the human factor at the International Snow Science Workshop, an annual event where avalanche experts meet and discuss ideas. They urged the group, which included officials from 11 countries, to recognize that "perception traps" could cloud backcountry travelers' judgment, and they urged educators to start talking about the human factor in avalanche courses. That year, the workshop was held at Snowbird in Utah, and Tremper recalls their presentation attracting a good amount of attention.

But Tremper also recalls many avalanche educators being hesitant to change their curricula and delve into the flaws of human psychology. "It was kind of controversial in those days because a lot of people who taught avalanche classes really didn't want to talk about it," Tremper says. "They were just like I had been. They thought people made logical decisions. They thought we just have to teach students about the science of avalanches and they'll automatically figure it out."

And that's pretty much where the avalanche community stood before Ian McCammon got involved. There was a growing awareness that human factors contributed to avalanche deaths, but most authorities weren't sure how serious the problem was and what they should do about it. Within a year of that workshop, however, Ian McCammon's friend Steve Carruthers died in circumstances similar to Yates' death. And McCammon would soon join the fight, creating a bridge between the world of avalanches and the world of social science.

In the aftermath of Carruthers's death, McCammon began a quest to understand the cognitive errors that could lead people to their death in the backcountry. And to do that, he needed data.

McCammon did not have the luxury of be-

ing able to conduct randomized experiments to prove, without a shadow of a doubt, the causes of avalanche deaths. For one thing, he didn't have the resources of a well-funded academic. But, even more fundamentally, it would be unethical to test concepts by playing with people's lives in the backcountry. He could not divide backcountry travelers into treatment and control groups by, for example, withholding essential information from one group and seeing if they were more likely to die.

Instead, McCammon had to rely on imperfect observations of the past. Avalanche professionals had long documented and archived reports of accidents, but this data had to be collected and coded to do statistical analysis. McCammon was forced to begin the long and arduous process of constructing a dataset.

Over several years, McCammon made trips to the headquarters of the Colorado Avalanche Information Center in Boulder. The CAIC maintains a historical archive that has detailed accounts of most avalanche accidents in the United States going back to 1950. Back in the late nineties, these were literally just paper reports. McCammon would camp out for days, sifting through the minute and often macabre details of accidents. He would categorize and quantify everything he could, painstakingly creating a usable dataset filled with information on the characteristics of the victims, the types of warning signs they encountered, and explanations, if any, for why they seemed to ignore these warning signs. Equipped with this dataset, which he would continue to expand in the following years, McCammon was able to do statistical analyses and find evidence for factors contributing to avalanche deaths.

One of McCammon's first studies using this dataset was published in 2000, and it investigated whether avalanche training had any effect on reducing accidents. At that time, he had a sample of 546 recreational accidents in the United States. The data wasn't perfect though. He only had information on whether the victims had avalanche training in 344 of the 546 incidents. Nonetheless, the study was one of the first times the avalanche community got a quantitative analysis suggesting behavioral problems systematically caused accidents in the backcountry.

McCammon's data suggested avalanche training did get people to mitigate risks by, for example, increasing the likelihood they went into the backcountry with beacons, probes, and shovels. But, he found, those with formal avalanche training nonetheless seemed prone to disregard all sorts of hazards. "In fact," McCammon wrote, "victims with basic formal training exposed themselves to more hazard than any other group, including those with no awareness of avalanches."

To explain why so many backcountry goers with avalanche training overlooked obvious hazards—hazards that training aims to get people to recognize and avoid—McCammon cited Kahneman and Tversky. The psychologists, he wrote, "have demonstrated that people in difficult and unfamiliar situations base their responses on simple rules, or 'heuristics.'" When people relied on this autopilot system in their brains, McCammon warned, it could lead them into trouble. While McCammon didn't identify which specific heuristics were most problematic in the backcountry just yet, he urged avalanche educators to reform how they teach students and figure out ways to improve their "decision skills."

In 2002, McCammon's dataset had grown to include 622 accidents, and he published evidence that four specific "heuristic traps" seemed to contribute to accidents again and again: "familiarity," "social proof," "commitment," and "scarcity" (each of which will be defined below). McCammon presented his findings at the International Snow Science Workshop. For many in the audience, it was likely the first time they heard the term "heuristic." But, he says, for old timers and avalanche pros, these concepts resonated with their own experience of accidents and near-misses in avalanche terrain.

"Traditional avalanche education places a heavy emphasis on terrain, snowpack and weather factors," McCammon wrote in his 2002 paper. "While there's no doubt that this knowledge can lead to better decisions, it is disturbing that the victims in this study that were most influenced by heuristic traps were those with the most avalanche training."

In 2004, McCammon published his most influential paper, "Heuristic Traps in Recreational Avalanche Accidents: Evidence and Implications." By then, his dataset had grown to 715 accidents, and he had identified two more heuristic traps in his data that were statistically significant—"acceptance" and "expert halo." He now offered the outdoor community comprehensive evidence for six heuristic traps that likely contribute to avalanche deaths. With some creativity, he rebranded some of their names and offered a handy acronym. He called it FACETS:

F stands for familiarity. It's the tendency for people to feel safe and ignore risk factors when they're in familiar terrain. An example is thinking, "I've snowboarded this slope a dozen times, so it must be okay to do it again."

A stands for acceptance. It's when people disregard rational judgment because they want to fit in and be accepted by their group. An example is skiing a slope because your two partners want to, and you don't want to make a fuss.

C stands for commitment. After people make plans, they tend to commit to them even if the facts on the ground change. It can make them blind to obvious avalanche clues that should spur them to change course.

E stands for expert halo. It's the tendency of people to defer their judgments to someone who they consider to be an expert, even if this so-called expert may actually be reckless or stupid or just flat-out wrong about avalanche risks.

T stands for tracks. It's the tendency of skiers and snowboarders to race for fresh powder tracks. It's sometimes known as "powder fever." Social scientists call this heuristic "scarcity," but McCammon changed it to create an acronym that would be more memorable for skiers and snowboarders.

S stands for social proof. An example is the tendency of skiers and snowboarders to see tracks on a slope and assume it's safe, even though the person who created the tracks may have been an idiot who just got lucky.

More than an acronym, FACETS is a clever mnemonic device because the term is familiar to those in the avalanche community. Facets are a type of weakly bonded, sugary snow, and they're one of the leading causes of the type of avalanche that most often kills people. Facets form because of thermodynamics within the snowpack, and they create what's known as a persistent weak layer. This weak layer is what causes a slab, or a well-bonded chunk of snow, to fracture and slide (when the slope is steep enough). Snow accumulating on top of a weak layer is like a house being built on a rickety foundation. Bruce Tremper calls facets "monsters in the basement."

Faceted snow is particularly dangerous because it lurks beneath the surface. It's invisible. And so, for McCammon, FACETS is not just a pun or a handy mnemonic device for backcountry goers. It's also a metaphor for the heuristic traps that can lead people into danger. "It doesn't really matter how deep a slab is," McCammon says. "If there's a weak layer underneath the slab—it's dangerous." Similarly, he says, it doesn't really matter how deep your knowledge is of skiing or snowboarding or snowmobiling. If you're making decisions based upon faulty rules of thumb—instead of a reasoned analysis or a system designed to help you rationally process information—there's a good chance your adventures in the backcountry can become treacherous.

McCammon now offered not only statistical evidence for six common heuristics that endanger backcountry travelers. He also offered a clever way to frame these heuristics to the avalanche community, and his work proved to be a clarion call that authorities could no longer ignore. His research was soon cited all around the world. His ideas gained traction in mainstream news outlets, like *NPR*, *The New York Times*, and virtually all ski publications. Avalanche educators began incorporating the FACETS framework into their classes. And McCammon was finally able to overcome the resistance that Fredston, Fesler, and Tremper had faced when broaching the human factor. Now a critical mass in the outdoor community recognized that deep-seated flaws in human psychology could routinely lead people to their peril in the mountains.

In "The Human Factor" chapter of his popular avalanche textbook, *Staying Alive In Avalanche Terrain*, Bruce Tremper credits McCammon's FACETS framework with revolutionizing the field: "It fundamentally changed the way avalanche workers thought about avalanche accidents and how they taught their students."

But, even as McCammon was developing the FACETS framework, he didn't believe it alone would make much of a difference. In the conclusion of his 2002 paper, McCammon cited psychological research that suggested simply providing people with a list of common cognitive errors "does not make people any less susceptible to them. Thus it seems likely that

effective human factors education must do more than provide a laundry list of heuristic traps: It must give people simple, viable tools for recognizing and mitigating heuristic traps and other decision errors in avalanche terrain."

So after McCammon developed his FACETS framework to get educators and backcountry goers to recognize potential flaws in decision-making, he began developing a tool to help people make better decisions when heading into the mountains. Like FACETS, this tool goes by a memorable acronym that doubles as a metaphor: ALPTRUTh, which urges backcountry adventurers to perceive the truth in the mountains.

ALPTRUTh is also known as the Obvious Clues Method. It provides backcountry travelers with a handy checklist of the seven most obvious clues of avalanche danger:

A stands for avalanches. Have there been any avalanches in the general area within the last 48 hours?

L stands for loading. Has there been any new snow, wind, or rain within the last 48 hours?

P stands for path. Are you traveling to a place with obvious avalanche paths? For example, a barren slope that is more than 30 degrees.

T stands for "terrain trap." Terrain traps are anything in the terrain that can increase the likelihood of death or injury if a slope slides. They include cliffs, trees, and gullies, all of which could be deadly if you're carried into them by even a small avalanche.

R stands for rating. It reminds backcountry goers to read their local avalanche center's daily report to see if they forecast any significant danger.

U stands for unstable snow. Have you seen or heard any cracking, collapsing, whumpfing, or any other obvious signs of instability within the snowpack?

Th stands for thaw instability. Has there been any recent warming of the snow due to sun, wind, rain, or higher air temperatures? Rapid warming contributes to the likelihood of a slope avalanching.

Using his dataset on past avalanche deaths in the United States, McCammon analyzed how many of these seven obvious clues were present in accidents before the victims got in trouble. And, he says, the average accident had five of the clues present before the avalanche.

McCammon imagined an alternate universe in which the skiers killed in avalanches had paid attention to the obvious clues in front of them and avoided avalanche terrain on the days they perished. He envisioned them using ALPTRUTh to create decision-making rules in which they picked a certain number of identifiable clues as a kind line in the snow: *if we see this number of ALPTRUTh clues today, we will turn back and not ski avalanche terrain*.

In a 2004 study, he and Pascal Haegeli crunched McCammon's dataset to figure out the most effective rule. They found that if skiers had set a rule to not ski slopes when they could identify four clues, 77 percent of them would have lived. And if skiers had set a rule of avoiding slopes when they could identify three clues, 92 percent of them would have lived.

McCammon's data may have been imperfect, but it strongly suggested that a clue-based decision aid could significantly mitigate carnage in the mountains. He saw ALPTRUTh as a kind of prototype. He hoped his research would spur others to take up the mantle and conduct more empirical analysis of how to prevent avalanche accidents. Some were skeptical of McCammon's findings, but many other researchers began following in his path.

For example, in 2012, a group of Norwegian scholars analyzed all avalanche accidents in Norway between 2005 and 2012, comparing the effectiveness of different decision-making tools. They concluded that ALPTRUTh was the most effective. They found that 50 percent of all avalanche accidents in Norway would have been avoided had skiers chosen to not ski when they could identify more than four clues. Further, they found that "100% of the accidents would have been avoided if the skier had not skied with one or two clues present."

The goal of ALPTRUTh is to get backcountry travelers to stop using faulty heuristics and emotions to make decisions in the backcountry. It urges them to instead objectively process information about avalanche danger. In other words, ALPTRUTh tries to get people to turn their brains off autopilot and think rationally about the information in front of them. In the lexicon of behavioral economists Richard Thaler and Cass Sunstein, it's a nudge. "It allows you to reframe things and get the psychological baggage out of the decision," McCammon says.

McCammon cites research by psychologist Gary Klein, who pioneered thinking on what he calls a "premortem." A postmortem, of course, is something a coroner does after someone dies to determine the cause of death. A premortem is an exercise in which people imagine a hypothetical future in which things go horribly wrong. They then use critical thinking to dissect the causes that could lead to such a disaster. Using ALPTRUTh, McCammon says, backcountry travelers can conduct a simple premortem. Before or during your trips into the mountains, he says, you should imagine a future in which you or your partners die in an avalanche. Then look at these seven obvious clues of danger. Are they present? If they are, how stupid will your decision look if there is an avalanche?

A major advantage of ALPTRUTh, McCammon says, is that it's designed to be fast and easy. Before backcountry travelers depart on an adventure, they can run through the list of factors quickly. "You can give someone a ninety-second avalanche course in the parking lot just with these seven clues," McCammon says. "Just say: 'Look for these things, and, if you see them, be very careful about your decisions.'"

Like FACETS, ALPTRUTh has been widely embraced by the avalanche community. All kinds of outdoor organizations and companies use it to promote public safety. It inspired the creation of Avalanche Canada's portable decision-aid tool, the Avalutor, which they market to backcountry travelers. Teton Gravity Research, an extreme sports media company, and Dynafit, a maker of ski boots and clothing, have sponsored online educational videos using the acronym. Jones Snowboards offers splitboard poles with graphics of obvious red flags of avalanche danger. The American Avalanche Institute declares to the public that both ALPTRUTh and FACETS are "two acronyms that can save your life."

When Ian McCammon began publishing papers in the early 2000s, the outdoor community had witnessed a decade in which avalanche fatalities rose to scary new heights. But in the 20 years that followed, the number of fatalities stayed pretty flat, with an average of about 27 per year in the United States. At the same time, backcountry winter sports have exploded in popularity; so while the absolute number of fatalities hasn't gone down, deaths have gone down significantly on a per-capita basis. This suggests that educators are doing a better job of training adventurers how to recreate safely.

That said, the 2020/2021 winter season saw a record-breaking 37 avalanche fatalities in the United States. With the COVID-19 pandemic increasing demand for outdoor activities, the backcountry witnessed an unprecedented surge of newcomers. Many had worried these newbies would haphazardly enter the mountains, sparking an explosion of avalanche fatalities. But, in retrospect, it wasn't really the newbies who proved to be the biggest problem. As McCammon had found in his dataset back in the early 2000s, more often than not, it proved to be experienced backcountry adventurers who got themselves in the most trouble. You could call it the avalanche paradox.

The snow-covered backcountry is a difficult place for human psychology. Snowy slopes are not inherently scary for experienced skiers, and it may be hard for them to recognize danger and act accordingly. Adventures in the mountains can be idyllic and exhilarating, and psychological research suggests people may struggle to get into a precautionary mindset in such settings. Recreationists also spend a lot of money on equipment, drive hours to get to trailheads, and make arduous climbs to reach their objectives. When they're at the top, they may disregard obvious hazards and make the mistake of riding a fun-looking steep slope because of all the costs it took to get there. Social scientists call this the "sunk cost fallacy."

The backcountry is also what psychologist Robin Hogarth might call a "wicked learning environment," where people get poor feedback on their decisions. That's opposed to what he calls a "kind learning environment," where people get near-immediate feedback on their decisions. Conventional sports offer such feedback. For example, if you shoot a basketball a certain way, and it consistently doesn't go in, there's a good chance you'll learn to shoot differently. That's because you get immediate feedback on your shots. And, often, you'll have

Ian McCammon (center) developed two highly influential avalanche safety acronyms, FACETS and ALPTRUTh, providing skiers with an efficient way to make better decisions in the backcountry.

ORIGINAL PHOTO: Karl Birkeland.

a coach and teammates who can help you along the way.

But the backcountry is a place where you can ski the same slope 99 times and not get hurt—and maybe that's just because you've been very lucky. The repetition can lull you into overconfidence, where your brain goes on autopilot, using heuristic rules—like familiarity—instead of critically assessing potential dangers. But weather conditions can dramatically change—and a persistent weak layer of faceted snow or other avalanche dangers can form in the snowpack. And, on the 100th time you head down your favorite slope, *whumpf*, you're a goner.

Beyond heuristics leading people to peril, research from behavioral economist George Loewenstein suggests that adventurers in the backcountry disregard obvious hazards because of the role that emotions can play in their decision-making. Some people, particularly young men, find taking risks to be inherently exciting, which is likely another contributor to unnecessary deaths in the backcountry. It's also one that could be harder to combat.

McCammon's aim, however, is not to dictate which risks adventurers should or shouldn't take. Instead, he seeks to help them base whichever decisions they make on a clear-eyed assessment of danger. Decisions will vary depending on each person's appetite for risk. "My goal has been to give people the tools that they need to objectively assess the hazard and make a risk-management-based decision," he says. "It's ultimately up to them."

To overcome all the psychological problems that people could encounter in the backcountry, Tremper says again and again in his textbook, "The system is the solution." Tremper says that paid backcountry professionals, like ski guides and heli-skiing outfits, have figured out really effective systems for navigating the hazards of the mountains. They rely on careful analysis of the snowpack. They have team meetings in the morning, running through checklists about conditions and doing premortem exercises. They identify specific areas where it's safe to travel and then stick to that terrain. They have alternative plans ready if on-the-ground conditions are worse than expected. In the evening, they debrief about their decision-making that day and assess how they can improve it in the future. Their rigorous systems explain, Tremper says, why backcountry professionals have remarkably low fatality rates despite their frequent outings in high-risk terrain.

But these are paid professionals with bosses and clients and bureaucracy and money on the line. A major challenge in the backcountry, Tremper says, is that most excursions are undertaken by non-professionals who must vet their decision-making themselves. The challenge, he says, is getting people to voluntarily adopt systems to keep them safe.

"When you're a professional operation—and people's paychecks depend on abiding by the rules—then you've got some leverage," Tremper says. "But how do you implement such a system in a peer setting? I think that's the holy grail of this whole human factors thing."

Before he retired, Tremper sought to improve how the Utah Avalanche Center and other avalanche centers communicate dangers to the public. "An avalanche forecaster in Colorado, Dale Atkins, told me this for years: 'We don't have an avalanche forecasting problem. We have a marketing problem.'" Tremper spent much of his career trying to solve this marketing problem. He, for example, created daily advisory reports that were easy—and even fun—to read. He used eye-catching graphics to communicate danger. He got the center to use social media and YouTube to educate the public about problems in the snowpack.

Tremper has long been concerned about the official warning systems that many avalanche centers use. In the United States and Canada, local advisory systems have adopted what's called "The North American Avalanche Danger Scale." It communicates dangers to the public with five levels: low, moderate, considerable, high, and extreme. Most accidents occur on days when centers warn that the danger is "considerable"—and Tremper has long suspected that one contributor to the problem is that the word "considerable" does not effectively communicate danger. "I hate that word," he says. "I wish I could wave a magic wand and change it—and I've sat on committees for years trying to get that done." He prefers a system adopted by many European countries, which communicates danger more simply with colors and numbers.

While there is still much room for improvement, avalanche institutions have made tremendous progress tackling the human factor. For example, the American Institute for Avalanche Research and Education, the main organization for educating American backcountry travelers, now embeds many of McCammon's ideas and analyses in its avalanche courses.

Interestingly enough, McCammon's FACETS framework has found resonance in realms outside of the backcountry. He's taught professionals like doctors, attorneys, and astronauts how heuristic traps can lead them into trouble. He says he gets them to think about bad decisions and mistakes they've made in the past. And then he has them run a "FACETS test," asking them to think about which heuristics potentially led them astray. Often, he says, they uncover patterns in their decision-making weaknesses—and he's hopeful that this will help them spot and override their defective decision-making rules going forward.

In 2016, the American Avalanche Association bestowed McCammon with their highest award. "It is impossible to quantify the number of people who have not perished in avalanches due to Ian's research and his impact on avalanche education and methodology," the presenter said. "However, what we can say is that Ian has effected a sea change in the way in which we talk not only about snow, but about ourselves."

People will, sadly, continue to make dumb decisions in the mountains that cost them their lives. But thanks to people like Ian McCammon—who took a tragedy and made it a call to arms—backcountry adventurers now have better tools and a more informed community working to nudge them towards safety. ■

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