Safety and Techniques

Psychological Factors and Cascading Errors: A Fatal Accident Case-Study

By William Storage and John Ganter

It began like many Sunday trips do in late summer. Four young cavers—David (17), Jane (21), Paul (17), and Robert (17)—walked upstream along the Elk River in northern Pocahontas County, West Virginia. The Elk is one of the largest sinking streams in the east. The fact that it was flowing heavily meant that water levels in the caves in the valley would be very high. As the group, talking and laughing, crossed the Elk, Jane fell in and got wet up to her chest. She would warm up soon. The cavers walked up the hillside and entered My Cave. Their plan was to traverse a few hundred feet of large, dry passage, rappel the 79-ft Outhouse Drop, and then walk upstream before emerging at the Dry Branch entrance. That is not what happened. A few hours later Jane was dead and two of her companions were lightless and hypothermic.

We will try to analyze what went wrong, showing that this was not a "catastrophe" in the normal sense, but a sequence of seemingly minor events that accumulated until it was too late for the cavers to get out of their predicament. The errors "cascade" like a chain of waterfalls feeding one another. A key concept here is "root cause," the deep-down reason (as far as we can tell in hindsight) that an incident occurs. Searching for the root cause is like finding a disease by studying its symptoms. We will suggest that the root cause of this death was poor judgment and technique, exacerbated by poor communication. Readers, knowing the outcome, may shudder as the sequence unfolds and think, "that could never happen to me because. . .". But many cavers will be forced to admit to themselves, "Yes, I've done that." In researching this article, we often recalled the number of occasions that we have made or seen the same mistakes. The only difference was the outcome. Hopefully, we can all learn from this after-the-fact study of a trip that went all wrong.

The four cavers made their way slowly towards Outhouse Drop, looking into alcoves off the large passage and climbing gingerly over breakdown that was unexpectedly muddy. The mud was a nuisance, but it did not seem to be a serious problem. David and Robert had been there before (as were many participants in the 1983 Convention geology field trip) and they had looked up Outhouse Drop from the other end of the cave, but they had not done the drop. The plan was for part of the group to descend. Then David would pull the rope and walk over the hillside to meet them at the Dry Branch entrance. David felt that the others depended on him too much as leader; he was to leave the area soon and this would give them some good practice. Jane had not initially wanted to come, but they had persuaded her. They had all done 40- to 60-ft drops, and were equipped with two large horizontal-caving packs and one vertical pack between them. Jane was wearing cotton coveralls; the others had synthetic oversuits with mixtures of wool and polypropylene underneath. The cavers arrived at Outhouse Drop.

Outhouse Drop is a hanging canyon that intersects the main stream passage (40 ft wide and probably 130 ft high at this point) just upstream of My Cave's terminal sump, the Crayfish Pool. The drop consists of a very steep 80 ft mud slope that leads to an awkward lip. From here, a 79 ft drop begins against the wall, then goes free. The drop is named for the sound that blobs of mud make as they fall down the drop. The Crayfish Pool is just downstream. Above it, Taggard Falls brings water in from the Elk River via a partially-explored passage.

The whole area is quite dynamic. From the east, the My Cave stream brings water from Simmons Mingo Cave and a separate drainage basin. From the west, Taggard Falls brings a portion of the surface Elk River water from a 93-square-mile basin. The Crayfish Pool itself is connected into the underground Elk in an unknown manner. Depending on the flows of each stream, the pool level varies enormously and unpredictably. The authors have seen a 40 ft range, resulting in anything from a small pool to flooding the passage 300 feet upstream. Disturbances in gravel and mud indicate probable flood depths of 80 feet. Much of the time it is a quiet place, with the stream a few inches deep, Taggard Falls a shower and the Crayfish Pool placid. This was how David remembered it as he made plans.

David uncoiled the rope and, taking care to avoid the slope, attempted to throw the free end down the pit. In the process the rope became somewhat tangled, sticking to the viscous mud. David advanced to fix the rope, but tripped and began to slide down the muddy slope. He grabbed the already-rigged rope and climbed back to the rig point. David tried to calm himself as Robert began to descend slowly. The slope is treacherous and just beyond the point where David had arrested his slide, there is no return without ascenders. Robert went over the lip and continued to the bottom. A waterfall below was very noisy, much more than David remembered. The cavers waiting at the top heard Robert yell "Off Rope." Then Robert called out, "David you have to come down."

David, Paul and Jane interpreted this as meaning that David should come along with the group and allow his nerves to settle. But Robert was having problems. The cave was completely different from what he remembered. What should have been a bouldery streambed was a deep pool of water—standing at the base of the drop he was waist deep. The trip was impossible. Robert intended for David to bring the vertical pack down, which contained their Prusik knots. He was already getting chilled; David was the one to handle this unexpected situation.

To those above, things seemed to be proceeding normally, although they were getting cold. As planned, Jane rigged on and descended.

When Robert realized that it was Jane and not David coming down the drop, he applied a bottom belay to try to make her stop. The rope was so muddy that this was ineffective, and she was soon in the water beside him, apparently with one of the horizontal packs. Robert was now quite concerned; Jane seemed hypothermic already. She could not swim. He had to get her out, but by the time the vertical pack arrived, she would be far too cold to use the knots. The only option was to get her across the pool to a mudbank upstream. From there they could exit via the Dry Branch entrance. Both were wet, mud covered and still wearing their seat harnesses.

Jane removed the Figure 8 descender from the rope. She took off the pack, asking Robert if it would float. Robert thought it was the light, horizontal pack. Yes, he said. He warned Jane that the water was over her head. She began to cross the pool. She made some

progress, probably walking on the mud slope and large breakdown underwater. Then she and the heavy pack, *which in fact contained the vertical gear,* sank. Robert had a webbing handline, but had not thought to use it.

Robert dove after her. He tried to reach for a pack strap but could not. He was exhausted in seconds and began to sink. He was able to grab the end of the rappel rope and pull himself back into the shallower water.

Meanwhile, David and Paul waited at the top. There had been no shout of "Off Rope," but the rope had gone slack. Soon after, Robert began frantic shouting. David realized they were in trouble and took action. He sent Paul for help. He began to rappel. Then he realized that his pack, with all his supplies, was at the top. He could not ascend the slippery clay. Paul had already left. David rappelled to the bottom, having to do a leg wrap for control. He felt "as if he was in the wrong cave."

David found Robert in waist-deep water and shivering uncontrollably. His carbide was out and he was using a Mini-Maglite. David calmed Robert, who was able to tell him what had happened. David tried to walk along the mudbank through the cold water. They realized Jane was gone and wanted to leave. Able to swim across to the other side, they made their way upstream. After a time David's carbide went out and the Mini-Mag expired. They waited to be rescued.

That is a brief reconstruction, based on the facts as reported to us, of a trip where everything seemed to go wrong. We will now take a look at the actions taken by the group while focusing on specific errors in techniques, decisions, and judgments.

When accidents and unsafe acts are attributed to errors, a common classification includes errors of judgment, poor technique, carelessness, negligence, and faulty communication. Contributing to these major categories are lack of experience, inadequate training,* physical conditions, and psychological conditions. Psychological conditions include fear, grief, frustration, anger, complacency, peer-destructive attitude, and superiority/inferiority mentality. Physical conditions might be fatigue, hunger, temperature extremes and noise. We recognize that these topics are difficult to organize and classify. However, we feel that an attempt at classification is necessary to perform accident analyses revealing root causes, not just symptoms.

To find the root causes behind questionable behavior, we have used a method derived from NASA (Billings 1975) for collecting human error information. The questions used there, slightly modified for our use, are as follows:

1. Was the necessary background information collected in advance? Was the information correct?

2. Was the information properly evaluated with respect to the current conditions? Did the party understand the true state of affairs?

3. Did the party select the wisest alternative? If not, why?

4. Was the decision effectively implemented?

To proceed safely, the answers to these must obviously be yes. Repeatedly asking "why" leads to root causes.

We can identify about five specific erroneous actions or events through the course of the trip, beginning with a caver starting down a rope with no ability to ascend. The NASA technique promotes error classification (e.g. communication, judgment, decision making) and reveals root causes. These are valuable in telling us where to concentrate our efforts in accident prevention, the ultimate goal of analysis. As we proceed through the events, the reader should refer back to the four diagnostic questions.

Event 1. Caver descends without ascenders.

Question 1. No. Robert has inadequate knowledge of general vertical technique. Once he goes over the lip and becomes fully aware of the noise of the water, and the muddiness of the rope, he is unable to return. The group apparently has not acquired information about the nature of the cave during flood, although this has been documented in NSS literature (e.g. Medville 1976). The cave, capturing water from a 93-square-mile basin, floods to a depth of at least 40 feet at the base of Outhouse Drop.

Question 2. No. Either the information about the nature of the cave is not available to the group or they know but elect, through complacency about the hazard, to proceed. It appears that they do not understand the true state of affairs; they do not realize that Robert will be rappelling into water, and that their plans and equipment are incompatible with the current state of the cave.

Question 3. No. They don't select the wisest alternative, which is to abort the trip. Factors affecting this decision seem to have included lack of perceived risk and, possibly, some peer pressure on Robert, considering the goal of weaning him from dependence on David's skills.

Question 4. Yes. Robert's decision to proceed is successfully implemented, but we will point out that there are a number of situations that require ascending gear to be available while descending a drop.

In this first part of the sequence, we traced an error in decision making to a lack of recognition of hazards, and ultimately to a mental condition of fantasy. We should note that this error by itself did not cause a mishap and could have gone unnoticed, had the next error not occurred.

Event 2. Jane rappels with vertical pack.

Question 1. No. Jane does not have vital background information. No one interprets Robert's message as meaning *change plans.* This communication error, one of mistaken meaning, might have been averted if whistles with known message codes had been used in anticipation of difficulty in hearing the message, a more common communication problem. In hindsight, we see a lack of planning for the special communication problems that often arise in ropework. Corrective action for either communication errors or unexpected situations on pitches must include the ability to stop and reverse direction.

Question 2 and 3. No. The communication error and nervousness over David's dangerous slip prevent re-evaluation of the situation. David's leadership abilities are clearly impaired. Planning and designing for a course of action do not occur. Also Jane's reliance on David's skills and knowledge reduces the likelihood of independent evaluation by her. She merely proceeds with an existing plan. Re-evaluation might have allowed David to descend to the lip, with ascending gear, and to re-establish communication with Robert.

Question 4. Yes. Her descent is completed as planned, except for the fact that she ends up in the water. Had she used a rappel rack instead of a figure-8, she would be able to stop above the water. However, without practice and ascending gear, this would be only a temporary reprieve. Even so, the drowning could be prevented.

Event 3. Mistaken pack identity.

Question 1. Probably not. Cavers generally prefer their own gear and avoid being separated from it. We can envision a number of failure modes resulting from the grouping of equipment used here. Standard technique might have precluded this confusion over packs.

Question 2. No. Jane and David do not understand the true state of affairs because they don't realize she has the vertical pack. Mistaken pack identity by Robert is probably aggravated by being cold and having inadequate light. Questions 3 and 4 provide no additional information in this case.

Event 4. Jane tries to swim with no belay.

Question 1. No. Jane does not have the essential knowledge that she will sink. The mistaken pack identity and an apparent lack of experience in swimming with baggage (she does not know how to swim) leaves her less able to judge the hazard and assess the risk. Likewise Robert assumes the pack will float, probably incorrectly even if the pack did not contain vertical gear.

Question 2. No. Jane is not experienced enough to evaluate the situation. Robert is thinking fast, but he is unaware of his options. Neither of them realize that she will sink.

* By "training" we are referring to repetition of procedures under simulated conditions and adherence to practices well accepted as safe. We are not advocating certification of caver skills by the NSS or any other organization.

Robert realizes that swimming is risky, but forgetting the possibility of belay, sees no reasonable alternative. Clearly the stress of the situation causes him to forget that possibility. Impending hypothermia and fear probably encourage Jane to try swimming even though she is not a swimmer.

Question 3. No. Had the decision been made with the right information, two options would be available. One is to swim with a belay. The other is to use the vertical gear (which they don't realize they have) to ascend. Either would result in continued hypothermia risk.

Question 4. Obviously not. The attempt to swim is a failure. Certainly, a dominant factor in this event is psychological stress in the form of anxiety and frustration. This is undoubtedly worsened by noise and hypothermia. We should note that training (repetition under simulated conditions) and knowledge of technique generally allow routine handling of these conditions. Wetsuits would probably prevent both hypothermia and sinking.

Event 4. David rappels without his pack. David and Robert attempt exit via other entrance.

Question 1. No. Haste to descend in response to an emergency prevents David from assessing the situation at the top of the drop.

Question 2 and 3. David's decision to rappel seems correct. Considering the obvious departure from original plans, he might better assess his own situation had he not known that a serious problem existed at the bottom. Although there is little he can do after arriving at the bottom, his composure and assessment of the situation there is commendable. The decision to exit via a horizontal route seems sensible. Outhouse Drop is known to be a very troublesome ascent, even with well tuned equipment.

Question 4. No. Exiting is unsuccessful because they run out of light. Adherence to accepted technique would have provided more suitable lighting.

A review of findings from the above traces the group's problems to poor technique (lack of training) and poor judgment (decision making). Decisions made throughout the sequence were greatly affected by stress. As David has noted in hindsight, his initial fall on the slope, while "harmless," set the stage for everything that followed. We should emphasize that this event enabled the accident to have fatal consequences through purely psychological factors; mental stress clearly impaired decision-making abilities. Decisions made earlier were affected by a lack of background information (unable to assess risk) and complacency (denying the risk). These decisions got the cavers in deeper trouble, which would require extraordinary ability to escape.

Some interesting assumptions seem to exist. Their complacency seems to have resulted from a condition of fantasy; My Cave is a place to have fun. Lack of background information on the cave, and lack of essential vertical skills were probably associated with the same enthusiasm and fantasy. Similar comments may be made about entering the cave improperly clothed and equipped.

Signs of hypothermia existed because the cavers had inadequate clothing and became wet and muddy. The problem was made worse because the least experienced caver, Jane, was the worst equipped.

We have discussed this subject with a number of highly experienced explorers of cold, wet, vertical caves. A common theme running through accounts of their attitudes and methodology is the negative fantasy. While still holding tremendous enthusiasm, they see caves, especially pits, as places filled with potential hazards—sharp rocks, swift currents, loose breakdown, and defective rig points. Much of their enjoyment comes from the safe negotiation, through sound technique, of these hazards. But they do not deny the existence of hazards.

In an introduction to *American Caving Accidents*, Steve Knutson (1988) made comments that seem to have been written about this exact incident: "The novice will be anxious when experienced people are at ease... will not have the right equipment, the proper clothes... All other things being equal [the novice] will be most likely to succumb to hypothermia... Keep this in mind when you take a novice caving."

A clear message reiterated in every issue of *American Caving Accidents* is to heed the weather. Aviation psychologists (Parker 1979) have noted that pilots likely to have weather-related accidents fly through clouds imagining that they are nothing but fluffy water vapor. Good pilots expect clouds to contain rocks and other airplanes. We see a strong analogy in caving. Those who see caves as pristeen wonderlands where they can escape everyday cares are headed for trouble.

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