The Learning Review:
Adding to the accident investigation toolbox

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Abstract

Accident investigation techniques have remained essentially the same for many decades, yet the recognition that complexity is increasing in most organizations demands an added form of inquiry. The Learning Review, first adopted by the U.S. Forest Service, explores the human contribution to accidents, safety, and normal work. It is specifically designed to facilitate the understanding of the factors and conditions that influence human actions and decisions by encouraging individual and group sensemaking at all levels of the organization. The Learning Review introduces the need to create a narrative inclusive of multiple perspectives from which a network of influences map can be created. This map depicts the factors that influence behaviors and can aid the organizational leadership to effect meaningful changes to the conditions while simultaneously helping field personnel to understand and manage system pressures.

Keywords: Accident investigation, complex systems, investigation models organizational learning, sensemaking.

1. Introduction

The Learning Review[1] emerged from organizational necessity, as the prescriptive model of accident investigation used by the U.S. Forest Service was unable to effect positive change to its most important element: the human. From 1995 to 2015 the Forest Service lost over 400 wildland firefighters in active fire operations. These line-of-duty deaths affected our community and our organization emotionally, yet no substantive changes in operation or policy resulted from the investigations that followed these accidents. The investigative model in use was delineated by the Serious Accident Investigation Guide (SAIG), which was formalized in 2001 (Whitlock, 2001). The SAIG was an amalgamation of the most common investigative tools in use; however, it did not provide wildland firefighting operations with the information needed to prevent accidents. Forest Service investigations often pointed to the failure of people, without understanding why they failed or what failure really meant to the system. In addition, the accident rates were trending upward.

The need for a new approach was also deeply felt at the field level. The results of investigations, called 'factual reports,' chronicled accidents from the often-biased perspective of the investigation team. Secrecy surrounded the process as the team collected 'evidence' and treated the incident like a criminal event, even if there were no criminal implications. Lurking beneath the surface of each causal statement was a sense that the firefighters *intended* to err, as almost all the listed causes in reports were counterfactual and did not provide the 'hard data' that the investigators claimed to have uncovered. Distrust brewed in the wildland firefighting ranks following the release of these reports, and people became less willing to share information or take positions of risk in the agency.

The SAIG was revised in 2005 with the best intent; however, it was an adaptation of several tools designed for the analysis of linear events that displayed straightforward cause-and-effect relationships, such as those developed in machines. These analytical methods of investigation are referred to as linear because they follow a straight path from problem detection to problem solution. The model can be useful when dealing with strict mechanical problems; however, it is not useful in human-centered work environments. People do not handle problems in a linear fashion—in fact, their solutions are often the antithesis of linear. The tools described in the SAIG worked well for the analysis of mechanical failures, but it did not help us to make sense of the complex human interactions that make up wildland fire operations.

The SAIG's approach is not uncommon in modern investigations. The approach does not consider that workers are balancing conflicting goals, messages, rules, regulations, direction, and even laws in their everyday encounters with complex work environments. In contrast to the SAIG instruction to create a timeline-centric narrative, we recognized the importance of building context around decisions and actions. This approach focuses on the correlation between the behaviors and the influencing conditions while avoiding any unintentional implication that workers intended to do harm, which is rarely the case. English is a particularly agentive

[1] The Learning Review is the process that formally replaced the Serious Accident Investigation Guide in 2014. It is the outgrowth of seven years of experimentation and research in alternative methodologies.

language; this means that by language alone we can inadvertently name a person as the agent of an action, even if that was not our primary intention. The words that people use to describe everyday actions can carry with them powerful implications that can lead to causal explanation of the event(s) (Vesel, 2012). Thus, accident investigators must be mindful of language throughout the process of gathering information and creating a report.

The SAIG process is designed to measure performance against an unreasonable expectation that work as designed fully represents the work required by the operational environment. Compare and contrast some of the expectations we have of our experts with those of novice workers (See Table I). We expect our novices to have knowledge of and to follow prescriptive policies, yet we expect our experts to adapt policies and direction to meet the challenges they face. We expect our novices to comply with instruction, direction, and procedures, yet we expect experts to improvise solutions. We expect novices to use knowledge of basic rules, regulations, policies, and procedures to navigate all work situations, yet we expect our experts to use complex adaptive problem solving and critical thinking skills to achieve results.

Table I: Comparison of Expectations, Novice to Expert (adapted from Pupulidy, 2005).

We expect our novices to:	**We expect our experts to:**
Have knowledge of prescriptive policy.	Apply rules to situations and adapt rules as needed.
Comply with instruction.	Know how to improvise to meet operational goals.
Know basic rules, regulations, policy, and procedures.	Use complex adaptive problem solving or critical thinking skills to achieve results.
Know and follow the plan.	Use intuition to know when to change the plan.
The basic goal is to "control" actions and limit decisions.	The basic goal is to facilitate "empowerment."

The fundamental difference is we expect to control the behavior of our novices while simultaneously facilitating the empowerment of our experts. When the expert is successful, we reward the innovation (rule bending, outside the box thinking, risk taking, etc.). However, when the outcome is adverse or negative, the tendency is to hold the expert to the expectations of the novice.

2. Designing the Learning Review

Pupulidy (2015) identifies to the need to recognize the differences between key system types and the corresponding need to review accidents through the lenses provided by each of these systems. Three systems were identified: simple, complicated, and complex (See Table II). This classification helped us to shape an understanding of the origin and application of traditional methods of investigation. The identification and mapping of these three systems also helped us to understand the limitations of the traditional methods of investigation and forced the development of an additional set of tools.[2] Wildland firefighting is a unique laboratory, as the work is largely conducted in the absence of simple and complicated components. Simply put, wildland firefighting takes place almost entirely in the realm of complex system operation, and as a result, traditional tools were stretched to the breaking point and a new set of tools had to be developed.

The first step was to understand that simple and complicated systems had some fundamental commonalities. Simple systems are made up of parts that are *interconnected* and *interactive*. Each part has a unique and specific role to play in the functionality of the machine. Think of a simple mechanical wristwatch in which each part, spring, or gear interacts in a specific and predictable way with its counterpart—this is required for time to be accurately captured and depicted. If a part breaks, the system fails in a very predictable way. Parts can be inspected, deficiencies found, and the part(s) can be replaced in a very procedural way. In a simple system, the cause and effect relationship is direct—for every cause there is a single effect. Trending failures can result in processes that can reduce the likelihood of failures at unwanted periods of operations. This has resulted in increased safety margins for a number of industrial applications.

Table II. Simple, Complicated and Complex Systems (Components list adapted from Page, 2011).

System Name	**Components**	**Frame**	**Pathway**	**Characteristic**
Complex	The parts are interconnected, interactive, diverse, and adaptive (they adapt, often predictably).	Organic – These systems cannot be broken down without losing the ability to understand interactions.	Sensemaking, improvisation, and learning—developing adaptations in real time.	Unlimited number of questions with an equally unlimited number of answers. Requires sensemaking.
Complicated	The parts are interconnected, interactive, and diverse,	Systemic – These systems are composed of nested sub-systems.	Directional flow relationships—cause and effect connections exist with a limited set of outcomes.	Each question has a limited number of discrete answers. Reacts well to analysis.
Simple	The parts are interconnected and interactive.	Mechanical.	Cause and effect connections are strong—problems can be solved.	Each question has one discrete answer. Reacts well to analysis.

Complicated systems share some commonalities with simple systems; the parts are interactive and interconnected—however, we can add diverse to this list. In this case, diversity represents the system design quality of multiple defenses in depth and/or the inclusion of redundant systems. This type of diversity strengthens the reliability of the

[2] See the US Forest Service "2017 Learning Review Guide." https://www.wildfirelessons.net/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=be30b128-0565-c151-2c68-cbe70dae0b85&forceDialog=0.

system because in situations where there is a component failure, other parts of the system can compensate, allowing for continued operations. Processes of this type are often depicted as flow diagrams where a malfunction can be identified, isolated, and bypassed, allowing other parts of the system to take the place of the failed component. This design generally allows for failures to occur gracefully (without major consequence) and catastrophic failure to be avoided.

Complicated systems exhibit cause and effect relationships that are as diverse as the system being analysed. For every cause, there can be a limited number of effects. The number of effects is limited to the number of system permutations (normal system variability). This type of system drove the development of many of the current models of accident investigation, such as the Swiss-Cheese, Fishbone, and the SHELL models. Analysis of complicated systems is often effectively conducted using these and other engineering analytical models.

Complex systems share the first three components (interactive, interconnected, and diverse); however, there is a very dynamic addition—adaptation (Page, 2011). Complex systems exhibit qualities of adaptation and can opportunistically change based on innumerable variables, or they can intrinsically change based on conditions, perceptions, and perceived stimuli. These systems are often *learning systems*. Complex systems defy full prediction or control (Morin, 2008). More data can help to refine predictions; however, these predictions are always fraught with some uncertainty. Human interaction with a complicated or simple system often evolves into a complex system. In these cases, it is challenging to avoid being seduced into mechanical or engineering models of accident analysis, which can only describe simple or complicated systems.

Adaptation is demanded by the uncertainty inherent in complex systems. Cause and effect relationships are non-linear—for every cause there can be an unlimited number of effects. This quality directly affects prediction and places the organizational ability to both control the system and control reactions to the system, out of reach. In the case of complex system interaction, the expectation on workers should be that they recognize when the system is delivering the 'unexpected.' In *novel* situations, experts recognize the need to perform outside routine, exemplifying an understanding of complexity—that no one can write a rule or process to fit every situation. The requirement on workers is to create safety in these situations. Professor Reuben McDaniel provides a doctrinal approach: "Workers are expected to make sense of the situation, learn in the moment, and improvise solutions, much like a jazz musician during improv sessions" (Author's personal conversation, 27 November 2015).

The need for workers to improvise actions when faced with novel situations places the investigator in a very difficult situation. Judging actions as right or wrong can only be accomplished when the outcome of the situation is known. This information is not accessible to workers—workers do not know the outcome of their innovation.

Pupulidy (2015) recognized that complex systems need a unique framework for post-accident learning, which we refer to as sensemaking. The actions of people are often, if not always, complex. People do not perform precisely the same way in all situations. This is the result of individual heuristics, unique learning, and biases. As no two humans will perform in exactly the same way when placed in identical situations, system analytics that rely on trending frequently fail. Our research shows the use of system mapping can be more useful to the sensemaking process.

3. Human Actions in Complex Systems

The way that people react to situations is influenced by many factors or conditions. If they are familiar with the work and the system is delivering the expected conditions, then routine responses are appropriate and will often work. In these cases, the routine response is also usually the most effective and efficient response (Klein, 1999). When the system delivers the unexpected and the worker follows a routine, success is not guaranteed. In this case, the routine or procedure is being applied to a situation that is outside the original intent or design. Routine processes, when applied to unpredicted or unexpected conditions, might work if the worker is lucky. Our research has shown that routine actions applied in novel situations can make the worker more vulnerable, as the routine response can result in increased risk exposure (Saddleback Fire Fatality Learning Review, 2013).

When the system is delivering the unexpected, the situation will require that the workers make sense of the conditions, learn in the moment, and innovate actions (McDaniel, 2007). With practice, this skill can be improved through coordination with others and is referred to as "Group Sensemaking" (Weick, 1995; Jordan et al., 2009; Maitlis, 2014). In time-critical situations, sensemaking is often overlooked, and people tend to "Satisfice" (Gigerenzer, 2010; Simon, 1956). This means that workers often find solutions that meet the minimum needs of the conditions they perceive in the moment; workers will act based on the limited information they have at hand. Satisficing is efficient; however, it represents actions driven by the need for efficiency, which can result in a loss of thoroughness (Hollnagel, 2009).

Satisficing can also be seen as a blend of action (intuitive response) and deliberate decisions. Our research indicates that this is common in wildland firefighting operations and is supported by Professor Gary Klein's work with structural firefighters. Acting/deciding is a natural human endeavour, and it takes place in a non-linear way. Every person tends to process information in his or her own way. The resulting responses, or action/decisions, are related to the perceived conditions or stimulus, and these can vary considerably from one person to the next (Panther Fire Fatality Report, 2008).

Work systems are becoming more complex daily, and this complexity brings a level of uncertainty. This uncertainty equates to greater risk in the system. If workers can equate uncertainty to risk, Professor John Adams suggests they will naturally react to create safety in the work system. This is something we see every time we <u>do not</u> experience an accident in the workplace (what we will call 'normal work'). With this in mind, we have to not only expect workers to create safety; we have to learn how to encourage it. Our research demonstrates the importance of recognizing the role of the worker in the creation of safety and the corresponding need for the worker to innovate solutions in complex situations.

4. Action/Decision – It's More Than a Choice

"To err or not to err is not a choice" (Dekker, 2006).

Following an accident, it can seem that some the actions of workers were careless or even negligent. In fact, discussions with investigators reveal that the term "stupid" is often casually used to describe these actions. These labels are common to events where the outcome is known. Leaders express this form of hindsight bias when they ask questions such as, "Why didn't they stop?" or "Why didn't the workers follow the rules?" The easiest way to respond to this line of inquiry is to point out, "Had they known that there was going to be an accident, they would have stopped or followed the rule." This line of questioning, quite unfairly, asks the investigator to explain something that did not happen. The Learning Review process recognizes the shortcomings of this approach and directs energy toward understanding what actually happened by asking, "Why did it make sense for the worker to do what he/she did?" (Dekker, 2006) This same line of reasoning is also applied to the leadership of the organization in order to begin to understand their motivations.

5. The Learning Review

The Learning Review is not designed to replace traditional accident investigation tools; rather it is a fully developed process designed to explore the social contribution to accidents and normal work. The process, while designed to review negative outcome events, has been used to understand the pressures and conditions in work that resulted in a desired outcome (See Figure 1) or what we call *normal work*.

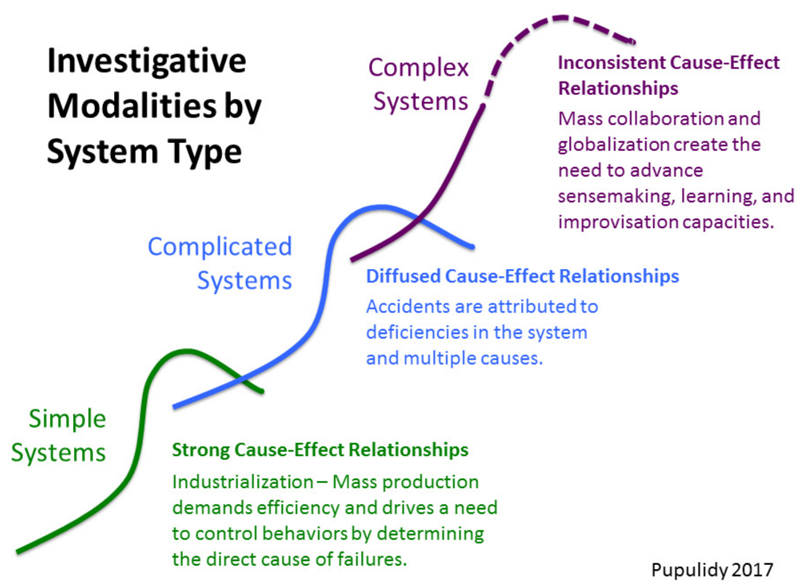

Figure 1. Investigative Modalities by System Type.

The Learning Review is an important addition to the existing body of investigative processes and is designed to help the recipients of learning products make sense of the event. The fundamental goal in producing a learning product is to move the reader from judgment of action to understanding the conditions that influenced people during the mission/operation. The foundation for understanding an event emerges from the recognition of these conditions. Leadership is asked to manage conditions in order to create a workplace where workers can be effective (Reason, 1990). Scenarios can be presented to workers under the premise that they explore the ways conditions can influence decision and actions in normal work environments.

5.1 The Learning Review began with operating principles:

- Forest Service employees are well intentioned and work within organizational systems to meet the expectations of leadership and the system.
- Accidents and incidents can be a by-product of the uncertainty inherent in complex systems.
- Enhanced accountability:
  - Prior to incidents, leaders and managers are responsible for knowing how the organization functions. At this point, traditional forms of accountability can be valuable.
  - After the incident, prevention is based on learning. The organization becomes accountable to learn all it can from the event.
- Actions and decisions are consequences, not causes. Following an event where the outcome was a surprise, the goal is to understand why the action or decision made sense to those involved at the time. This is based on the premise that, "If it did not make sense to them at the time, they would not have done it."
- Conditions shape decisions and actions; revealing these conditions will aid the agency and personnel in understanding how to recognize, change, and react to conditional pressures.

These principles led to the development of tools and techniques specifically designed for the Learning Review. One tool is the complex narrative, which includes a deliberate emphasis on reducing the inadvertent bias of language. We realized that human recollection is fundamentally inaccurate, no matter when the story is gathered. This knowledge allows us to approach interviews in a different way. The stories shared by participants are captured and recorded as perspectives—we don't attempt to create a factual account from the narratives or a plausible single view of the incident—which is what most investigative processes demand. Instead, we recognize witness accounts as perspectives, and we try to capture each as accurately as possible, but with the understanding that these accounts may be in conflict with one another. This conflict is an important part of the narrative, as it may lead to different questions. For example, "Did the participants recognize their differences in perspective?" And if so, "How did they communicate that understanding?"

The complex narrative is paired with a network of influences map, which is a representation of the conditions that influenced decisions/actions. It is similar to Rasmussen's Acci-map with some striking differences. For example, it is based on *influence*, rather than cause. Searching for causes restricted our teams from exploring some very critical aspects of our organizational culture and prevented us from asking hard questions regarding the perverse nature of some of the influences we discovered. For example, we had trouble making the case for the influence of overtime pay on the behavior of our crews. We had recorded admissions of workers indicating that overtime played a role in decision-making and risk acceptance, but we could not prove a causal link. Simply shifting the conversation to 'influence' was enough of a softening of language to allow a dialogue to begin that could explore the possible ways that overtime nudged decisions.

The initial network of influences map represents the interaction between the conditions as they were perceived during the incident; however, our goal is to move quickly into the normal work environment. Prevention is forward looking, and our processes were all retrospective. Our traditional techniques kept us rooted in findings that led to causes and then to recommendations, with each needing a direct tie to the accident. This method prevented us from examining the influences in normal work operations, which is where safety really starts. We now present the complex narrative and the network of influences map to focus groups, which helps us understand how the conditions noted during the accident are perceived in normal work environments. If the focus groups indicate that the conditions are common in normal work, we focus attention there. If the conditions are unique to the incidents, we place them in another category.

Conditions are a currency for change. We have found it best to divide the conditions into four categories to facilitate organizational acceptance and learning:

1. Conditions that are outside the control of the agency leadership.

2. Conditions that will have meaningful impact but will take time to change (these are usually cultural issues).

3. Conditions that will have meaningful impact on the operations and can be changed quickly.

4. Conditions that, if changed, would likely have a negligible impact.

It is a fallacy that simply attending an accident investigation course suddenly imbues the investigator with the ability to directly create social corrections to the system. We used to develop recommendations that were meaningless or impossible to put into action. Instead, the Learning Review Team humbly engages those closest to the work to help craft recommendations. Recommendations are now a collaborative effort with field personnel who provide input through focus groups.

6. Conclusion

The Learning Review was specifically designed for complex systems, particularly those involving people. The Learning Review is fundamentally a social sensemaking activity that reviews an accident, incident, or even normal work for clues as to where workers contribute to the safety of operations or where the system inhibits this capacity.

This approach describes a new way to view the human contribution to work and safety, one that strives to understand the context of action. This context is converted into dialogues that serve as opportunities to share stories that challenge deeply held assumptions about the way things are supposed to be done. The goal is to place learning above correcting and fixing. This moves us from judging actions as right or wrong, and inadvertently, people as good or bad, to a forward looking exploration of our system.

References

Adams, J. (1995). *Risk*. Oxen, England: Routledge.

Dekker, S. (2006). *The field guide to understanding human error.* Burlington, Vermont: Ashgate Publishing Company.

Gigerenzer, G. (2010). ”Moral Satisficing: Rethinking Moral Behaviour as Bounded Rationality.” *Topics in Cognitive Science*, 2, pp. 528-554.

Hollnagel, E. (2009). *The ETTO principle: efficiency-thoroughness trade-off; why things that go right sometimes go wrong*. Burlington, Vermont: Ashgate Publishing Company.

Jordan, M. E., Lanham, H. J., Crabtree, B. F., Nutting, P. A., Miller, W. L., Stange, K. C., & McDaniel, R. R., Jr. (2009). “The role of conversation in health care interventions: enabling sensemaking and learning.” *Implementation Science*: IS, 4.

Klein, G. (1999). *Sources of Power: How People Make Decisions:* MIT Press.

McDaniel Jr., R. R. (2007). “Management Strategies for Complex Adaptive Systems.” *Performance Improvement Quarterly*, pp. 20, 21.

Morin, E. (2008). *On Complexity.* Cresskill, NJ: Hampton Press, Inc.

Page, S. E. (2011). *Diversity and complexity.* Princeton, NJ: Princeton University Press.

“Panther Fire Fatality Report.” (2008). Wildland Fire Lessons Learned Web site. https://www.wildandfirelessons.net.

Pupulidy, I. (2015). *The transformation of accident investigation: From finding cause to sensemaking*. S.l.: [s.n.]

Reason, J. (1990). *Human Error*. New York: Cambridge University Press.

“Saddleback Fire Fatality Review.” (2013). Wildland Fire Lessons Learned Web site. https://www.wildandfirelessons.net.

Simon, H. A. (1956). "Rational Choice and the Structure of the Environment." Psychological Review. 63 (2): pp. 129–138.

Vesel, C. (2012). *Language bias in accident investigation.* Master of Science Degree Dissertation. Sweden: Lund University.

Weick, K. E. (1995). *Sensemaking in organizations.* Thousand Oaks, CA: Sage Publications.

Whitlock, C. (2001). *Accident Investigation Guide*: 2001 ed. Missoula, Montana: Forest Service, United States Department of Agriculture, Missoula Technology and Development Program.