Chapter 2

Thinking About Human Performance Risk

"You cannot change the human condition,
but you can change the conditions in which humans work."[1]
-Dr. James Reason
Ph.D. and Professor Emeritus

"What does this button do?"
-Unknown

Life Changing Step

As a seasoned nuclear navy operator in the late 1980s, I (Ron) had spent my last three years of an eight-year career training enlisted and officer nuclear operator trainees at a prototype training facility in Idaho. Most of my days were spent running drills, checking trainees' knowledge on power plant systems, and sitting on qualification boards to evaluate each trainee's readiness for the rigor of life aboard U.S. Navy nuclear-powered vessels.

Early in my assignment, I qualified to be one of a handful of gas-free engineers.[*] One evening, I was directed to check the atmosphere of a large, empty, 30-foot deep, 40-foot-wide tank that typically held water. This task required me to check the tank's atmosphere with various test devices after it had been purged with fresh air. This was common practice, and on any given shift I might be asked to test several empty tanks and voids. This testing was done to verify that the tank's atmosphere was safe for human habitation. Typically, I would notify the control room before each tank entry—no formal prework discussion was conducted even though the task is inherently dangerous.

In those days, the Navy had limited fall protection requirements for ascending and descending ladders. There was no clear requirement to be tied off, and there was no fall arrest equipment for that matter, as is required and used today. My only required personal protection equipment (PPE) for this entry included coveralls, a double layer of outer rubber gloves with thin cotton inner gloves, double plastic booties (notably slick), and a self-contained breathing apparatus (SCBA) strapped to my back, which hampered my visibility and maneuverability.

After putting on the "proper" PPE, I performed some initial tests at the opening of the manway and found no abnormal gas readings. I hung my test equipment around my neck so I could descend into the tank. As I descended the ladder into the tank, maintaining three-point contact,

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[*] The gas-free engineer is qualified to certify a confined space as being safe for others to enter without the use of an air-purifying or supplied air respirator (SAR). A confined space would, however, need to be ventilated prior to entry to ensure an adequate supply of breathable air. Gas-free engineering is equivalent to a toxic gas inspector, confined space inspector, etc.

three rungs from the top one foot slipped between two rungs. I fell backward. I frantically reached out for the ladder rungs, grasping only air, when suddenly and luckily the handwheel of the tank of my SCBA caught the edge of the access opening behind me just long enough for me to grab the ladder. Breathing heavily, I held myself in place for a few moments while I gathered my wits. I quickly exited the tank and laid prostrate on the tank roof, with my heart pounding out of my chest. Several minutes passed before I could move. I am not sure that I had ever been more scared than I was for those few seconds when I thought I was going to die. I removed my PPE and reported the incident to my supervisor.

Does Ron's descent into the tank on the ladder satisfy the definition of a CRITICAL STEP? Consider the following facts:

- He was physically poised 30 feet above the bottom of the tank (pathway).
- Each step on the ladder rungs was a human action, subject to his own fallibility.
- He was wearing slick rubber boots not conducive to secure traction on the ladder's rungs when his feet slipped.
- The sudden—immediate—slip jostled Ron such that he lost his grip of the ladder, falling backward away from the ladder due to the weight of the SCBA strapped to his back.
- Fortunately, the air tank valve caught the edge of the access (luck).
- It would take only a few moments to fall 30 feet to the floor.
- He was not wearing a fall-protection safety harness, which was not a required safety device at the time (impacts ability to "fail safely").
- The impact with the tank floor would either have killed Ron or at least broken some limbs or caused internal injuries—all intolerable.

The answer is yes. All the attributes of a CRITICAL STEP's definition are present: improper human action and immediate, irreversible, intolerable harm (a near hit). In fact, the first step onto the ladder was the first CRITICAL STEP of many (literally, in this case). One slip—one misstep—almost cost Ron's life. Fortunately for Ron, he lived to tell the story—this story. He was lucky. But as we should all know, luck is not a reliable defense. Yet, he did everything right according to the Navy's safety standards at the time. *He believed he was safe*. This incident became a defining moment for Ron—truly, believing it was an act of God that he survived; others call it coincidence. While he was more than a few feet or so above the floor of the tank, each step descending the ladder was "critical;" every step had to be performed with precision. You could say Ron's descent on the ladder was a "continuous CRITICAL STEP."

Human Error = Loss of Control

Humans are a key source of variation in operations (uncertainty due to fallibility). Of all the activities of an operation, human performance is the least reliable. "Human error" is often simply an action inappropriate for current conditions. Regardless of what it's called or labeled, human error, active error[*] in particular, is a principal source of risk to the assets of production and safety. That includes people. Yes, people can be a hazard, but they are also heroes. People, especially those in the workplace, are also a key source of resilience because of their adaptive

[*] Active errors are those occasions when a human action triggers immediate harm.

capacity. It is our systems and people together that lead to successful outcomes. This concept will be developed more fully later when we talk about augmenting adaptive capacity.

An event is an undesirable occurrence involving significant harm (injury, damage, or loss) to one or more assets due to an *uncontrolled* transfer of energy, movement of matter, or transmission of information. The anchor point in any event occurs at a point in time when control over the damaging properties of energy, matter, and information is lost—when the destructive potential of built-in hazards is unleashed because of a loss of control and/or the absence of adequate protection.[2]

When errors trigger events, too often people are blamed for their lack of judgment or carelessness. We encourage the reader to think of human error not as some immoral act— "They should have known better"—but to think of it as a *loss of control*. Senior managers simply (and immorally) blame the individual, ignoring relevant system defects. This happened to Ron. He did everything "right." But the Navy system was not designed to accommodate human fallibility. This chapter describes a way of thinking about the risk human performance poses to assets in the workplace, another type of battlefield. Better thinking yields better management.

Human Performance Risk Concept

To manage or control anything, you must understand how it works. Mental models are representations of how things work, explanations of cause and effect that managers commonly use to make decisions. Good mental models allow managers to see relationships, to ask better questions, and to predict outcomes of a decision or action more reliably and accurately. When working with complex adaptive systems involving multiple human tasks, relationships between system components become obscure. Therefore, interactions and the effects of feedback must be checked periodically to validate the mental model's reliability and utility. Consequently, it is always important to cling to a *sense of unease* when using mental models to make decisions about safety. We are about to introduce a couple of them to you.

Whenever work is done to create value, three physical things are present concurrently:[3]

- *Assets* – things important, of high value, to an organization
- *Hazards* – built-in sources of energy, matter, or information used for work to create value
- *Human beings* – actions by fallible people intending to create value

Arranging these elements into a conceptual model, we develop a more systematic way of thinking about risk. This model helps you think about and manage the risk introduced by the uncertainty of human performance. Figure 2.1 illustrates the occurrences in a work activity, where all three are in intimate proximity or physical contact, generating risk—risk to the asset.[4] This risk is not usually a permanent state of work. Most human activity involves set-up, communications, adjustments, clean-up, etc.; the coupling of the three elements of risk occurs less often during operations, except where production work is performed.

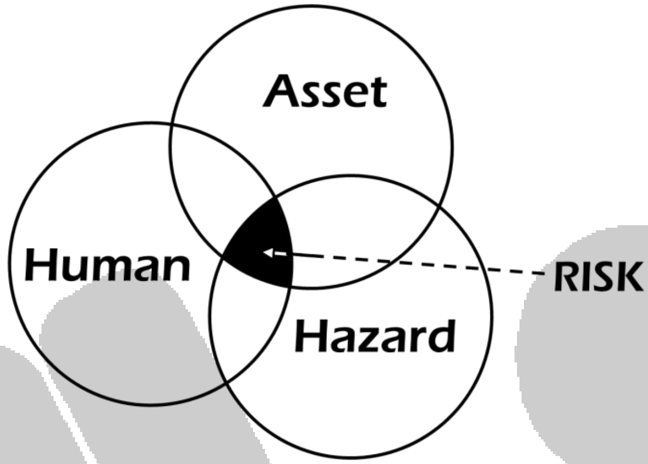

Figure 2.1 The ***Hu*** *Risk Concept* illustrates the primary elements in managing the risk that human fallibility poses to operations. The interfaces (overlaps) of these elements introduce risk: losing control of a built-in hazard and harming an asset—an event. (See Muschara, T. (2018). *Risk-Based Thinking* (p.26).)

CRITICAL STEPS are to be performed with the same sense of unease as with the use of a firearm. Either way, you can end up dead. Although the use of firearms may not be familiar to everyone reading this book, anyone who has watched an action movie has seen firearms used. Hollywood loves firearms. Take a handgun with a cartridge (bullet) in the chamber—a hazard to any living thing. The safety is off. The firearm is ready to shoot. The person with a scowl on the face, wielding the firearm, has a finger on the trigger, and the muzzle is pointed at another human being. Tension rises because there is now risk.

As illustrated, the ***Hu*** *Risk Concept* is a control problem: control of 1) the co-location of a hazard with an asset, 2) human interactions with either, or 3) the moderation of built-in hazards used during work processes.[5] A means of controlling (managing) human performance risk is described in the next section. But first, let's better understand the three elements that create risk.

Asset – Things of Value to Protect from Harm

Assets include anything of value, tangible and intangible, important to the organization's reason for being—its mission. For a business or organization to be sustainable, the assets, such as people, product, property, facilities, equipment, and even shipping labels, used to create or deliver a company's outputs must be protected from harm. Whatever is essential or key to its safety, productivity, reliability, environment, and profitability is of utmost importance to the members of a responsible organization.

Harm is defined by the asset, where permanent damage, injury, or loss can be sustained. All tangible assets have a safe operating envelope (SOE), defined by one or more critical parameters, within which the asset's integrity (safety) is preserved, if the respective critical parameters are not exceeded.[6] For example, the SOE of a car tire includes wall condition, tread depth, air pressure, temperature, and speed.[7] The collection of critical parameters for one or more assets is frequently called the system's "design basis." Measures of an asset's critical parameters serve as the vital signs of the asset's safety, quality, system reliability, or operability of equipment and processes. In most cases, the conscientious use of procedures and built-in controls and barriers will help the front-line worker operate within an asset's SOE.

Hazards – Built-in Sources of Potential Harm

Work creates value and requires the transfer of energy, the movement of matter, or the creation and transmission of information. Work requires energy to create a change (recall, $W = f \bullet d$). Movements of matter require work. It takes work to create and communicate information. Hazards are built-in sources of potentially damaging energy, matter, and information, necessary for creating value during operations, research, services, etc.[8] All industrial facilities incur risks employing hazards in various forms to perform their functions, such as electrical energy needed to run a motor that drives a pump. See examples of the following three sources of hazards:

- *Energy* – electrical, kinetic, chemical, heat, elevation, thermal, such as ovens and stoves, hot surfaces, gasoline engines, nuclear reactors, rotating equipment
- *Matter* – transport of solids, liquids, or gases from one place to another, such as automobiles traveling on highways; seagoing tankers hauling large quantities of crude oil; pipelines carrying natural gas; pinch points; aircraft traveling at 600 mph and at 35,000 feet; airborne viruses, bacteria, and various forms of contamination
- *Information* – data, documents, proprietary designs, trade secrets, instructions, policies, such as software, intellectual property, personal financial information

Regardless of the type of energy, all energy sources are hazardous when they exceed certain thresholds. Harm (damage, injury, or loss) is an unwanted change in the desirable qualities of an asset, defined by its critical safety parameters. Built-in physical hazards make harm a real possibility, especially when we lose control of them.[9]

We tend to assume hazards are stable—always present and knowable beforehand. Most are, some aren't. Occasionally, unknown hazards arise during work—landmines—appearing unexpectedly. Risk is dynamic; pathways for work (harm) from built-in hazards come and go. To sustain the safety of assets over the long term, workers must be capable of managing both known and unknown hazards (surprises) when they occur; that is, able to adapt and fail safely.

Human Fallibility – Potential for Losing Control

The occurrence of an event is usually triggered by some human action while a person is at the controls.[10] Variations in behavior, including human error, lead to variations in results. As described earlier, we encourage you to think of human error more as a loss of control than a fault of the individual. Human error is a normal feature of human nature—one is inhuman if faultless (most likely dead). Human performance introduces uncertainty at the exact time and place we want to create value. Nominal error of commission is approximately $3x10^{-3}$, which equates to 99.7 percent reliability; roughly 1 to 3 errors in 1,000 attempts.[11] As mentioned previously, people are generally 99.9 percent reliable, ranging to 99.99 percent for mastery or expert performance. Sounds good, but would you rely on those numbers for life-and-death situations?

The guiding principle in the healthcare industry is "first, do no harm." That's the proper mindset that front-line workers, including their supervisors and managers, need in high-hazard operations. A risk-based, conceptual model of workplace human performance provides managers with the structured means to proactively manage human performance risk. On the contrary, an event-based approach—learning late by reactive reporting and event analysis—will only get you so far. So, what do you manage?

Human Performance Risk Management Model

The interfaces between Hazard and Asset, between Human and Hazard, and between Human and Asset (the overlaps in the ***Hu*** *Risk Concept* of Figure 2.1) provide opportunities for control. Referring to the ***Hu*** *Risk Concept* as a springboard, a more practical form, depicted in Figure 2.2, the ***Hu*** *Risk Management Model,* suggests what to manage—*pathways* and *touchpoints*. Pathways and touchpoints are necessary interactions to do work. But, if not managed proactively, harm can ensue during work with a loss of control. Interactions are denoted by plus signs (+).

Figure 2-2 The ***Hu*** *Risk Management Model* pinpoints the two work-related interfaces—pathways and touchpoints (denoted by the plus (+) signs)—that must be controlled to minimize the risk of harm during operations. (See Muschara, T. (2018). *Risk-Based Thinking* (p.30).).

> **Note**: Two types of human interactions are of interest in work: those with hazards and those with assets. This linear model is limited in that the interaction between human and asset is not represented explicitly, though the human-hazard interaction is the more important of the two. However, the touchpoint between the human and hazard is an adequate reminder that there is a touchpoint with the asset. All models are wrong, but some are useful.[12]

Pathways

The first + sign represents the existence of a pathway for work, involving an impending interaction between an operational hazard and an asset.[13] Pathways are necessary for work to happen—a force is required to create a difference. A pathway exists when a hazard is poised in such a way as to expose an asset to the potential for a change in state—an opportunity for good (value) and a vulnerability for bad (threat). Whenever there is an opportunity to add value, there is an associated risk to do harm—to extract value. For example, the open door on an aircraft cruising at 13,000 feet offers a pathway for a skydiver about to jump. RIAs, performed earlier, create pathways.

For Ron, the pathway was from the manway at the top of the tank to its floor 30 feet below. which was the only entrance into the tank. The ladder offered a "controlled" descent into the tank. Without fall protection, any slip would involve an irreversible fall after gravity takes over.

Pathways are particularly important because the potential for harm is now dependent on either a single human action or an equipment malfunction. For Ron, his descent was dependent on secure traction of every step. Front-line workers must be wary of the creation and existence of pathways, which occur often during production operations. But, occasionally, pathways emerge unexpectedly, which we call landmines and will explore later in Chapter 5.

Touchpoints

The second + sign represents a human touchpoint. A touchpoint involves a human interaction with an asset or hazard that *changes the state* of that object through work. Critical Steps always occur at touchpoints. A touchpoint is work, involving a force applied to an asset or hazard over a distance, using tools or controls of hazardous processes. Manipulations occur at touchpoints that influence either the *status* of the asset and/or the *control* of a hazard. After a touchpoint is performed, things are different. Positive control of a touchpoint is most important when a pathway exists between an asset and a hazard. Because of human fallibility, risk occurs at touchpoints that involve a change in the state of assets; human error could occur during work or a loss of control of a hazard, such as a foot slipping off a ladder rung. Ron had four touchpoints as he descended the ladder: two feet and two hands. But he lost control of three of them; he didn't lose complete control because one foot remained on one rung. A touchpoint includes the following characteristics:

- *human action* – bodily movements; exerting a force on anything
- *interaction with an asset or hazard* – physical handling—force applied to an asset or hazard
- *work* – force applied to an asset over distance or the control of a hazard[*]
- *change in state* – "the result of work—distance" suggests changes in one or more parameters that define the state of the asset or the control of the hazard (*off* to *on*)

Table 2.1 offers some examples of important everyday tasks, pinpointing the associated assets, hazards, pathways, touchpoints, and potential harm if control is lost. The *responsiveness* and *consequence* of an interaction determine the importance of the human action involved. Critical Steps are those human actions that involve quick system responsiveness and severe consequences when control is lost. As described by Charles Perrow in his book *Normal Accidents*, a Critical Step is a good example of a "tight coupling" situation.[14]

> **Note**: As illustrated in Figure 2.1, ***Hu** Risk Concept*, risk exists when interfaces exist between an asset, a hazard that can do work, and a human that can influence either. When there is no pathway with a hazard there is no risk to the asset—no work can be done. When there is a pathway but no touchpoints with either the asset or the hazard's control, there is no human performance risk. But it's the occurrence of touchpoints *after* the creation of a pathway that tend to be critical to safety. If a touchpoint is performed improperly, the performer can lose control, and harm—an event—is likely to occur.

[*] Thinking—the creation of knowledge—is work on a cellular level.

Table 2-1 Examples of pathways and touchpoints among assets, hazards, and humans.

Task	Asset	Hazard	Pathway	Touchpoint	Harm
Crossing a street on foot	Pedestrian	Moving vehicular traffic	Street	Stepping into street	Death or bodily injury
Ironing (pressing) a garment	Delicate silk garment	Heat from iron	Iron poised inches above garment	Hand holding handle of iron	Permanently scorched garment
Shooting a firearm	Person	Bullet at high velocity	In front of muzzle	Finger on trigger	Death or bodily injury
Purchasing products or services on the Internet	Credit card number	Theft of identify	Internet connection (via Wi-Fi or cable)	Moving mouse pointer over “Buy Now” button or finger poised over *Enter* key	Loss of funds or personal financial information
Filling syringes with drug product via a filling machine	Drug product (liquid form)	Bacteria or other forms of contamination	Pipe or hose (with pressure differential)	Grasping valve handwheel	Contamination of drug product from upstream piping system
Family enjoying swimming at a neighborhood pool	Toddler (child)	Pool water	Airway to lungs	Standing within inches of edge of pool	Death from drowning
Reading e-mail messages	Personal computer (programs and data)	Malicious software (viruses)	Internet connection (via Wi-Fi or cable)	Finger poised over mouse with pointer over link	Loss of control of PC, loss of data, cost of recovery, delays, etc.
Cleaning a 480-volt circuit breaker	Electrician	High voltage	Metal conductor	Grasping metal wire	Shock / death from electrocution

Occasionally, the *human is the hazard*, as in the case of manual activities when people apply the force that triggers harm. In these situations, the pathway and the touchpoint are one and the same, such as a surgeon’s cut, recording critical data, chiseling a stone sculpture, sports in general, circus acts, and children between the ages of two and five (in jest, they must be corralled for their own protection). Shooting oneself in the foot with a pistol is a classic example.

Fast and Slow Thinking

Many problems occur when high-risk tasks are performed mindlessly. Mindfulness is an ongoing state of alertness, an active intuition.[15] Relative to safety, the mind must be nimble, alert to threats to assets, the occurrence of pathways during work, planned and unplanned. As mentioned previously, work must slow down for high-risk tasks when pathways have been created. Dr. Daniel Kahneman, in his landmark book, *Thinking, Fast and Slow*, characterizes human tendencies in response to risk-laden decisions. Dr. Kahneman describes two modes of thinking at work in the mind, which are described more explicitly in Table 2.2:[16]

- *Fast Thinking* (FT) – A subconscious approach to thought, quickly making intuitive decisions with little or no effort or deliberate attention, often automatically with no obvious awareness of voluntary control
- *Slow Thinking* (ST) – A conscious, analytical approach to decision-making; mindfulness characterized by attention to details and orderly concentration on an issue—active use of working memory

Table 2-2 Descriptions of Fast and Slow Thinking. FT is an efficient response to the perception of risk. ST tends to be thorough in responding to an existing threat.

Fast Thinking (FT)	**Slow Thinking** (ST)
• Reflexive, usually accurate for experts in their knowledge and skill domain • Always ON • Intuitive, pattern recognition • Easy (skill-based performance) • Quick (efficient) • Influenced by expertise, emotions, priming, instinct, beliefs, biases, and heuristics	• Reflective, prudent, and deliberate • Turned ON and OFF (active use of working memory) • Rational and logical • Effortful (rule- and knowledge-based performance) • Protracted (thorough) • Influenced by knowledge, facts, rules, and mental models • Invoked by intuition, novelty, danger, and learning

Chapter 5 describes more about the application of slow thinking using **Hu** Tools. **Hu** Tools trigger RISK-BASED THINKING, which is slow thinking.

Expert Intuition

Everyone has this "inner voice" we call intuition, often whispering things to us, sometimes called a "gut feeling," but otherwise known as instinct. Problem is often we don't listen to it until it becomes a shout, and then it's too late. Intuition is the perception of a situation without the support of conscious reasoning; thinking that is ongoing, yet unconscious. Intuition is FT. What makes intuition *expert intuition* is the depth of knowledge and experience accumulated by the individual—recognition of patterns accumulated over time. Expert intuition has been corroborated as an effective way of knowing and recognizing impending or potentially harmful situations.[17] In addition to the names listed earlier, expert intuition is also known as questioning attitude, internal risk monitor, and chronic unease. Despite what it's called, it is developed through in-depth technical education and training, mentoring, recurrent training, prework discussions, and proficiency on the job—practice—lots of it. It reinforces a mindfulness attuned to impending transfers of energy, movements of matter, or transmissions of information around key assets. Why is expert intuition so important?

Ideally, all known CRITICAL STEPS are denoted in approved work documents, but some are hidden. Despite doing their best, engineers, managers, planners, and procedure writers—given their experience, their understanding of the technology, available information, and their assumptions about the work—regularly produce guidance inconsistent with what front-line workers actually encounter. CRITICAL STEPS may be embedded in chunks of work that is considered skill-of-the-craft, which are not written out in detail. Similarly, supervisors and front-line workers could simply overlook one or more CRITICAL STEPS during their individual preparation and the team's prework discussion. Finally, work conditions may change or differ from what was assumed in the procedure or originally planned. Therefore, front-line workers can never let their guard down when working with important assets and/or hazardous processes.

Question: Can expert intuition be managed—can it be improved? It depends. Generally, the bases for intuition change slowly; some aspects are unchangeable. According to researchers, intuition is not readily educable, but it can be cultivated.[18] [19] Truly, it takes years to develop technical expertise. However, front-line workers can be primed to detect threats for work in the near term. In a team environment, intuition can be augmented by conversations about the work to be accomplished during a prework discussion and during work with frequent in-field, group conversations that boost situation awareness and improve the accuracy of mental models of work in progress. Training, practice, mentoring, and experience are the best bets for the long term. The most amenable aspect of intuition in the short term is emotion. You may influence a front-line worker's mindful wariness by imparting a bit of fear of what could go wrong during an upcoming work activity referring to operating experience, if available.

Conversations Create Safety

Communication is the lifeblood of high-risk operations. Communication conveys information and meaning most effectively through conversation between persons to create *shared understanding*. Like an engine's oil pump, conversation enables the flow of information that sustains successful work. Without an oil pump or if there are blockages in the system, it doesn't matter how much oil is in the engine's sump. If a person has information but doesn't share it, there is no communication. Conversations, especially face-to-face, enhance RISK-BASED THINKING about CRITICAL STEPS.

Safety is what people *do* to protect assets, and people act on their mental models—their understanding of how things work. The likelihood for success, and likewise avoiding harm, is influenced by accurate mental models. Process mental models are constructed by effective technical training. Situation awareness—mental models of current work processes and workplace conditions—are formed through a combination of technical expertise, expert intuition, and conversations. Too often the mental models of what is happening differ among the members of a work group or even among organizational units. Only currently accurate mental models are useful. Reality is what you bump into when mental models are wrong. To remain accurate, they must be updated constantly to match the context of the technology, the work, the workplace, and the work group. This occurs with careful consideration of what must go right from conversations about what is happening and what is needed.[20] When considering the overall contribution to safety and productivity, the constant updating of a team's or work group's collective mental picture of the work and the real-time risks enhances their capacity to detect the unexpected and to form a path to success.

Robust workplace conversations foster openness, candor, and informality.[21] Though important at times, formality tends to choke the amount of information disclosed; people say only what is required. Also, "professional courtesy" can be hazardous, passing along only good news, not wanting to upset the boss, arousing unwanted attention. On the contrary, despite rank and time on the job, healthy workplace conversations should stimulate questions (and answers), new ideas, and new insights, adding depth and richness of understanding and enabling engagement. Such conversations cannot occur if people are more concerned with protecting themselves from the ire of their bosses or ridicule from co-workers. If people fear repercussions, they will not openly share what they know. Safety, quality, reliability, and even productivity will suffer.

Too often we have heard, "Be safe out there," "Pay attention," "Follow procedures," or "Don't make mistakes." Though inspirational, these words are about as effective as putting up signs around your plant that read, "Safety First!" These words and these types of signs can inhibit our mindfulness and make safety a four-letter word in the minds of workers. Instead, talking about CRITICAL STEPS and RIAs adds specificity to their understanding of safety, avoids generalities, and enhances mental engagement when done regularly. It's important from a risk perspective that conversations related to CRITICAL STEPS end with closure—who does what, when, and how. The way front-line workers talk about their work either keeps them alert to the dangers at CRITICAL STEPS or allows complacency without their realizing it.

We believe managers and executives have a moral responsibility to remove every impediment to the flow of information. The lubricating quality of oil goes bad over time. If truth and facts are replaced with generalities, half-truths, and assumptions, communication is suspect, and the organization will suffer for it. Therefore, managers must instill a "will to communicate" throughout the organization.[22] Managers must establish structures that reinforce communication, eliminate obstacles to communication, and monitor the health of communications.

Remember, *it's not who's right, it's what's right*. The nature of social interactions across group boundaries has been studied extensively.[23] [24] Research supports the importance of clear, factual, and uninhibited conversations about what must go right among informed and technically competent workers and among organizational groups. Diversity of insight leads to safety and success, yet conversations take time. Interpersonal skills, diversity, and healthy relationships strengthen conversations. How to develop these is beyond the scope of the book; however, there are good texts written on these topics by Aubrey Daniels, Edgar Schein, and Rosa Antonia Carrillo, to name some popular authors.

Key Takeaways

1. Humans are key sources of both risk (hazards) and resilience (heroes).
2. In an operational environment, human error is better thought of as a loss of control of work—of transfers of energy, movements of matter, or transmissions of information.
3. Production, risk, and safety happen at the same time. Risk exists at the convergence of asset, hazard, and human interaction.

4. A pathway is an operational situation in which an asset's transformation (change in state) is poised (exposed) to occur by either a transfer of energy, a movement of matter, or a transmission of information.
5. A touchpoint is a human interaction with an asset or hazard that changes the state of the asset through work or the control of a hazard's release.
6. Positive control of a touchpoint is most important when a pathway exists between an asset and a hazard.
7. Both the establishment of pathways and the occurrence of touchpoints are normal and necessary for the organization's success. No work would happen otherwise.
8. A CRITICAL STEP exists when there is a pathway for work dependent on one human action, a touchpoint, those human actions that involve rapid system responsiveness and severe consequences to assets when control is lost.
9. Thinking must slow down for high-risk tasks when pathways have been created.
10. Expert intuition enhances the recognition of CRITICAL STEPS.
11. Workplace conversations foster the flow of information about what's really happening, enhancing situation awareness. This is contingent on the degree of openness, candor, and informality.

Checks for Understanding

1. While pulling the starter cord from the top of the engine of an old-style lawnmower, one foot is under the blade housing.
   a. Does a pathway for harm exist? If so, what is the asset and the hazard?
   b. Are there any touchpoints with an asset or hazard or both? If so, what are they?

2. True or False. A pathway for electrocution exists when an electrician is about to touch an exposed conductor with a test probe while performing a voltage measurement on an energized 120 vac circuit.

3. Yes or No? Walking down a long flight of stairs is a series of CRITICAL STEPS?

(See Appendix 3 for answers.)

Things You Can Do Tomorrow

1. Relative to the organization's event analysis practices, consider reframing "human error" as a "loss of control." What might be the ramifications to systems learning if such a change was made?
2. Using the structure and headings of Table 2.1, fill out the table for explicit high-risk work activities or a recent event for specific work groups. Considering the information, discuss how the risk of losing control would be managed using the ***Hu** Risk Management Model*.
3. In a gathering with first-line supervisors (managers), ask them how they "manage" the risk of human error in their high-risk work tasks? Introduce the concept of CRITICAL STEPS to them, soliciting their ideas on how to apply it to their work.
4. During any production meeting, listen for whether safety is separate or part of the conversation. Do meetings start with a "safety moment," followed by the "real work?" Or is

protection of assets part and parcel with talk about the production objectives? Do they understand that production and safety happen at the same time?

5. Recollect close calls from your personal life when your "inner voice" whispered to you just before the incident occurred. Ask yourself how a conscious transition to slow thinking could have influenced the outcome.
6. Brainstorm a list of activities that can be performed with fast thinking. With slow thinking? Afterward, discuss why it's acceptable/unacceptable.

References

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[1] Reason, J. and Hobbs, A. (2003). *Managing Maintenance Error: A Practical Guide*. Aldershot: Ashgate (p.96).
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