Chapter 5

ACCIDENT CAUSATION AND INVESTIGATION: THEORY AND APPLICATION

Chapter Objectives

After completing this chapter, you will be able to

- Explain the benefits of understanding accident causation theory
- Define the terminology associated with accident causation theory
- Identify the activities involved in risk assessment
- Compare and contrast the various accident causation theories
- Explain the purpose of accident investigation
- List the activities involved in accident investigation

Introduction

Safety and health professionals are responsible for aiding management in anticipating, identifying, evaluating, and controlling hazards in the workplace. Responsibilities include advising the management team of the risks the facility faces. The professional then calls upon management to eliminate the hazards associated with those risks before losses occur. Knowledge of accident causation theories permits the professional to more thoroughly recognize and communicate information regarding organizational safety problems.

Employees with little safety and health experience might walk near a punch press leaking lubricating oil on a shop floor and recognize a slipping hazard. For the more experienced professional several questions are raised:

- What is the lubricant?
- Is it a fire hazard?
- Is it a health hazard?
- How do the operators clean the spillage?
- Is the solvent used for cleanup a health hazard?
- Are hazard communication programs, training, and personal protective equipment required to use these products?
- Should less hazardous lubricants and solvents be considered as substitutes? Is the punch press guarded?
- Are there repetitive motion or other ergonomic hazards associated with the operation of the press?

It is possible to greatly expand the list of questions one might ask, given the few signals provided in this simple scenario. The more information and experience available, the more safety and health hazards are likely to be anticipated and recognized.

There are many theories associated with the causes of accidents, ranging from simple to complex. Some focus on employees and how their action or lack thereof contributes to accidents. Others focus on management and its responsibilities for preventing conditions leading to accidents. Theories are not facts; they are tools predicting relationships that *may* exist in the future.

Accidents are not events happening by chance; they have specific causes. Nor are they random events; they are usually predictable and preventable. By applying one or more theories, the professional is more likely to predict accidents and initiate activities preventing their occurrence or recurrence. Accidents represent failures in the system or management problems in the organization. Management controls all the variables surrounding accidents. It creates the work environment. It advertises for, hires, places, trains, and supervises workers. Management can reward for work it wants done and punish when procedures are violated. If the worker makes a fatal error, both OSHA and the courts will likely hold management responsible. Public opinion rarely favors management in accident situations.

In an accident investigation, management may blame the worker. This is referred to as the *pilot error syndrome*; in other words, the pilot is blamed because he is dead, injured, or considered a weak scapegoat and cannot defend himself. ***It is important to emphasize the safety professional is looking not for a place to assign blame, but for errors in the system.*** These errors can then be addressed so problems and accidents will be prevented in the future. Anytime the professional fails to find the error in the system, causing or permitting the incident to occur, the investigation stops short. Once the worker or pilot is blamed, management and the management system are off the hook; therefore, there is no reason to continue to search for why the accident occurred.

Anytime the accident investigator seeks to place blame, employees run for cover. Stories will be concocted and the truth may not be found. A safety professional in a major company was investigating a helicopter accident following a crash involving a pilot and a few employees on a surveillance mission of the plant property. Although no one was injured, the copter was a total loss and the investigation yielded no causes to be addressed. All aboard agreed the crash was due to wind shear. Some months later, the investigator found himself with one of those onboard and questioned him further regarding the incident with a promise of no reprisals. After encouragement, the employee revealed that during the flight, the pilot yelled, "Watch this!" He proceeded to chase a deer through the woods with the copter. With his attention focused on the animal he failed to notice the clearing where he was flying become narrower; nor did he see the rotor clip some trees until it was too late to avoid damage. Once on the ground, the pilot coached the other employees to agree on a story to tell the safety investigator. With this new information the company established a new policy regarding flying altitudes, and the likelihood of the problem resurfacing was reduced. The investigator was true to his word and pursued no disciplinary action. To do so would likely have slowed the flow of information in future accident investigations. Even in this case of flagrant employee disregard of safety, management accepted responsibility for the problem and initiated appropriate action.

The Concepts of Risk, Incidents, and Accidents

"*Accident*" refers to a loss-producing, unintended event. "*Incident*" is an unintended event possibly not causing a loss. For example, a truck with a flat tire pulls off the side of the road into tall grass, bordering a hill. The driver does not realize the grass is disguising a slope; he doesn't check the ground before driving onto it and the truck rolls down the hill. If no slope were present—only solid ground next to the road—the truck would not roll down the hill. In either case, if the driver never checks the slope, it is simply a matter of chance as to whether or not a loss occurs. If no loss occurs, it could be described as an "incident." Incidents include so-called near misses and other accident-type events not resulting in loss. If the truck rolls down the hill, causing injury, death, or property damage, the event is now described as an "accident." Whether or not an incident is also an accident, accumulating data about such events is worthwhile. The response to either should be the same in terms of active intervention with engineering or administrative controls, or the establishment of other controls.

As defined in chapter 1, "***risk***" describes both the probability and severity of a loss event. ***Probability*** refers to the likelihood of the occurrence of an event. When used as part of a risk assessment tool in system safety, probabilities can be categorized as ***frequent, probable, occasional, remote***, and ***improbable*** (Roland and Moriarity, 1990). By studying safety-related data, it is possible to determine statistical trends for a variety of factors, such as the types of accidents (e.g., falls to the same level, being struck by a falling object, or overexertion injuries) or location where injuries are taking place (e.g., warehouse, assembly, paint shop). Using the data on the frequency of occurrence of these events, it is possible to classify injuries, property damage, or other loss factors in terms of one of the probability categories.

$$\text{Risk} = \text{Probability} \times \text{Severity}$$

Probability and frequency of loss events are only half of the risk picture. The severity of the loss event must also be considered. "***Severity***" refers to the magnitude of the loss in a given period of time. ***When used as part of the risk assessment tool in system safety,***

the severity of a particular condition is classified in one of four categories:

1. Catastrophic
2. Critical
3. Marginal
4. Negligible

These four categories correspond to death or loss of a system, severe injury or major damage, minor injury or system damage, and no injury or system damage respectively (Roland and Moriarity, 1990). When viewed on a severity continuum, near misses, scratches not requiring first aid, or brief assembly line stoppage might be considered negligible reactions to an incident. At the opposite end of the severity continuum, multiple fatalities or an explosion that destroys an entire building represent catastrophic loss events.

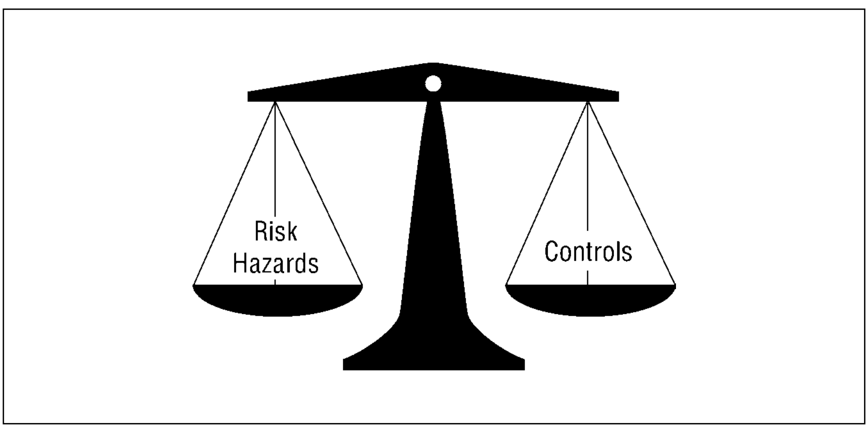
All companies face risk and the resultant potential losses on a daily basis. They willingly accept risk—even welcome it—with the hopes of gaining financial return. All new marketing and business ventures are examples of businesses taking risks. These are considered speculative loss exposures because they offer the opportunities for gain and loss. Exposures offering potential for loss with no opportunity for gain are referred to as ***pure loss exposures***. Examples of pure loss exposures include those to theft, fire, or accident.

Determining exposures a company faces is a formidable task, but it must be undertaken. Companies may choose to bring in an outside consultant or depend on the advice of a representative such as a loss control expert from their insurance company. This person will review activities, procedures, and processes to determine where exposures occur. Once exposures are identified, the company selects the critical exposures and prioritizes them in order of importance. Even large corporations have limited resources and must make decisions as to where to commit their resources. While controlling losses may seem to the safety manager like the most important way to utilize resources, the marketing director may feel that a new product introduction should take precedence. The safety function competes with every other entity in the enterprise for resources, so it is important for the safety manager to clearly understand what needs are to be addressed, why, how much addressing the needs will cost, and the projected return on investment. The effects of investments in safety are measured by management against the ***expected*** return on investment as well as the return on investment of other potential ventures.

Establishing priorities allows the safety professional to determine problems to attack first and where to spend the allocated safety budget. Non–first aid injuries occurring with great frequency may appear, at first glance, to be events not ranking very high on the safety professional's things-to-do list. On the other hand, occasional confined-space entry fatalities are usually of great concern because employee deaths often result. Multiplying the probability of loss from a fire or any event in a given year's time and the likely amount to be lost from such a fire or event (severity) gives the safety practitioner a relative gauge as to where to place resources for controlling losses.

By considering both probability and severity, the risk assessment provides the safety practitioner with a much sounder perspective for judging the significance of hazards. Once the risk assessment is performed, it is possible to determine the types of controls that most effectively eliminate the hazards (see figure 5-1).

Figure 5-1. An illustration of the balance between risks and hazards in the workplace and controls necessary to minimize their efforts.



There are a number of control techniques available for treating loss exposures. These can be broken into two categories: loss control techniques and financing techniques. Loss control techniques include the approaches mentioned in chapter 6, "Introduction to Industrial Hygiene." A company may choose engineering or administrative controls or personal protective equipment to deal with losses. Engineering controls include building a ventilation system to reduce explosive vapor levels, whereas administrative controls might limit exposures to toxic materials. Issuing personal protective equipment (PPE) such as respirators is the last line of defense against hazards in the workplace. Refer to chapter 6 for a detailed examination of these three types of control methods.

A company might try to avoid the loss altogether. If a company is in the business of producing football helmets, it may choose not to market the product due to the potential liability it would face if a wearer of one of its helmets was injured. Instead, it may choose to produce novelty lamps that look like football helmets to limit its liability exposure.

Sometimes a company can reduce exposure by substitution. Instead of using a strong acid as a solvent to remove excess glue from a finished product, a company could use citric acid for removing glue to reduce the likelihood of a worker being injured.

Occasionally, the company may choose to *transfer* the liability to another party, rather than run the risk of loss itself. If removing glue could not be accomplished safely in the plant, the company may choose to have the product shipped to a contractor who would remove the glue in the contractor's plant. If the contractor's workers are overcome by vapors from the solvent, then the contractor would typically hold the liability.

Another form of risk transfer is insurance. *Insurance* is designed to permit the company to shift the financial consequences of the risk to an insurance company. By paying the insurance company's *premiums*, the organization can expect specified *benefits* in the event of a loss. The insurance company enters into similar relationships with a number of other companies by selling them insurance policies too. With large numbers of insureds, it can more accurately estimate its own losses. When an insured company turns in a *claim*, the insurer is able to pay because it receives enough money from similar insureds not having losses to cover the cost of claims and still make a profit.

Some companies simply retain their loss exposures without dealing with them. This may be a result of ignorance or choice. When companies choose to retain their own exposures, they may ignore them, or attempt to reduce them using one of the methods already mentioned; or they may, in fact, self-insure. Ignoring the risks may make the owners more confident, but dealing with the risks will make them more prepared for loss. Self-insurance is simply no insurance; the company retains the loss exposure. It should only be undertaken by companies with the financial resources necessary to absorb potential losses.

All of the above assume the accident will occur. The safety practitioner can use accident causation models to pinpoint hazards in the occupational environment. Systematic, proactive hazard identification will assist the practitioner in establishing loss control strategies and determining the cost-benefits of the controls to be implemented.

The following review briefly examines some of the most popular accident causation theories. The bibliography found at the end of this chapter provides the student with resources to examine this area in greater detail. The intent is to provide examples of accident causation theories representative of past and current thinking. The bottom line benefit is to provide the tools necessary to seek out and eliminate the causes of accidents.

Accident Causation Theories?

Single Factor Theory

The ***Single Factor Theory*** states there is a single and relatively simple cause for all accidents. A good example of this theory would be in determining the cause of worker hand lacerations. Because utility knives are used in the operation, knowing something about the cause of these accidents does not necessarily stop the problem. Other contributing factors such as the product or the work methods, as well as corresponding corrective actions, are overlooked when a single factor is considered the only cause. This theory is virtually useless for accident and loss prevention.

Domino Theories

There are several domino theories of accident causation. While each domino theory presents a different explanation for the cause of accidents, they all have one thing in common. ***All domino theories are divided into three phases:***

1. ***Precontact phase:*** refers to those events or conditions that lead up to the accident
2. ***Contact phase:*** refers to the phase during which the individual, machinery, or facility comes into contact with the energy forms or forces beyond their physical capability to manage
3. ***Postcontact phase:*** refers to the results of the accident or energy exposure. Physical injury, illness, production downtime, damage to equipment and/or facility, and loss of reputation are just some of the possible results that can occur during the postcontact phase of the domino theory.

Domino theories represent accidents as predictable chronological sequences of events or causal factors. Each causal factor builds on and affects the others. If allowed to exist without any form of intervention, these hazards will interact to produce the accident. In domino games, where the pieces are lined up and the first one is knocked over, the first domino sets into motion a chain reaction of events resulting in the toppling of the remaining dominos. In just that same way, accidents, according to the domino theories, will result if the sequence of precontact phase causes is not interrupted.

Heinrich's Domino Theory

H. W. Heinrich developed the original domino theory of accident causation in the late 1920s. Although written decades ago, his work in accident causation is still the basis for several contemporary theories.

According to Heinrich's early theory, the following five factors influence all accidents and are represented by individual dominos:

1. Negative character traits leading a person to behave in an unsafe manner can be inherited or acquired as a result of the social environment

2. Negative character traits are why individuals behave in an unsafe manner and why hazardous conditions exist
3. Unsafe acts committed by individuals and mechanical or physical hazards are the direct causes of accidents
4. Falls and the impact of moving objects typically cause accidents resulting in injury
5. Typical injuries resulting from accidents include lacerations and fractures

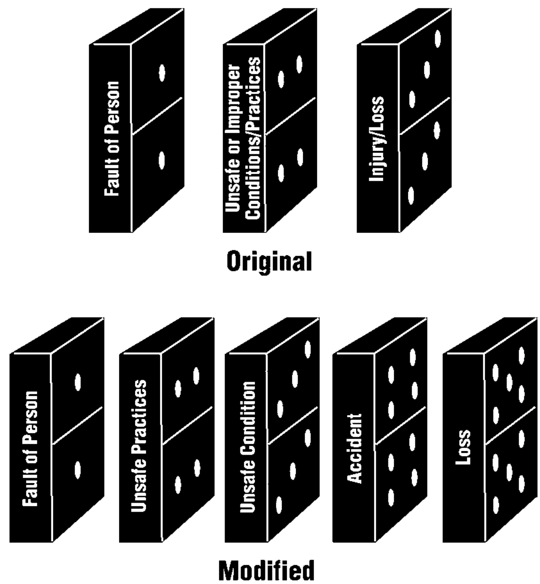
The two key points in Heinrich's domino theory are that (1) injuries are caused by the action of preceding factors, and (2) removal of the events leading up to the incident, especially employee unsafe acts or hazardous workplace conditions, prevents accidents and injuries. Heinrich believed that unsafe acts caused more accidents than unsafe conditions. Therefore, his philosophy of accident prevention focused on eliminating unsafe acts and the people-related factors that lead to injuries (Brauer, 1990).

Bird and Loftus' Domino Theory

Bird and Loftus (1976) updated the domino sequence to reflect the management's relationship with the causes and effects of all incidents. ***Bird and Loftus' theory uses five dominos that represent the following events involved in all incidents:***

1. ***Lack of Control—Management.*** Control in this instance refers to the functions of a manager: planning, organizing, leading, and controlling. Purchasing substandard equipment or tools, not providing adequate training, or failing to install adequate engineering controls are just a few examples represented by this domino.
2. ***Basic Cause(s)—Origin(s).*** The basic causes are frequently classified into two groups: (1) personal factors such as lack of knowledge or skill, improper motivation, and/or physical or mental problems, and (2) job factors including inadequate work standards, inadequate design or maintenance, normal tool or equipment wear and tear, and/or abnormal tool usage such as lifting more weight

Figure 5-2. An illustration of Heinrich's Domino Theory of Accident Causation.

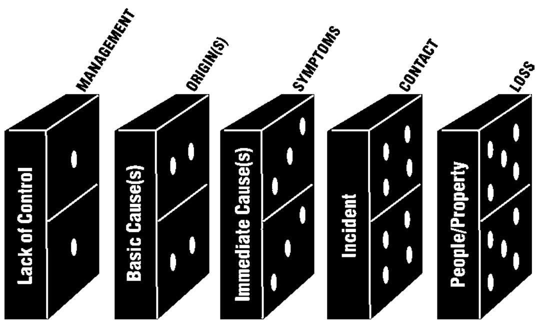


than the rated capacity of an overhead crane. These basic causes explain why people engage in substandard practices.

3. ***Immediate Causes(s)—Symptoms.*** The primary symptoms of all incidents are unsafe acts and unsafe conditions. "When the basic causes of incidents that could downgrade a business operation exist, they provide the opportunity for the occurrence of substandard practices and conditions (sometimes called errors) that could cause this domino to fall and lead directly to loss" (Bird and Loftus, 1976, p. 44).

4. ***Incident—Contact.*** "An undesired event that could or does make contact with a source of energy above the threshold limit of body or structure" (Bird and Loftus, 1976). The categories of contact incident events are often represented by the 11 accident types. The

Figure 5-3. An illustration of Bird and Loftus' Theory of Accident Causation.



11 accident types include struck-by, struck-against, contact-by, contact-with, caught-in, caught-on, caught-between, foot-level-fall, fall-to-below, overexertion, and exposure (ANSI Z 16.2).

5. ***People-Property-Loss. Loss*** refers to the adverse results of the accident. It is often evaluated in terms of property damage, as well as the effects upon humans, such as injuries and the working environment. The central point in this theory is that management is responsible for the safety and health of the employees. Like Heinrich's theory, the Bird and Loftus domino theory emphasizes that contact incidents can be avoided if unsafe acts and conditions are prevented. Using the first three dominos to identify conditions permitting incidents to occur, and then ensuring the appropriate management activities are performed, can eliminate accidents and related losses according to this theory.

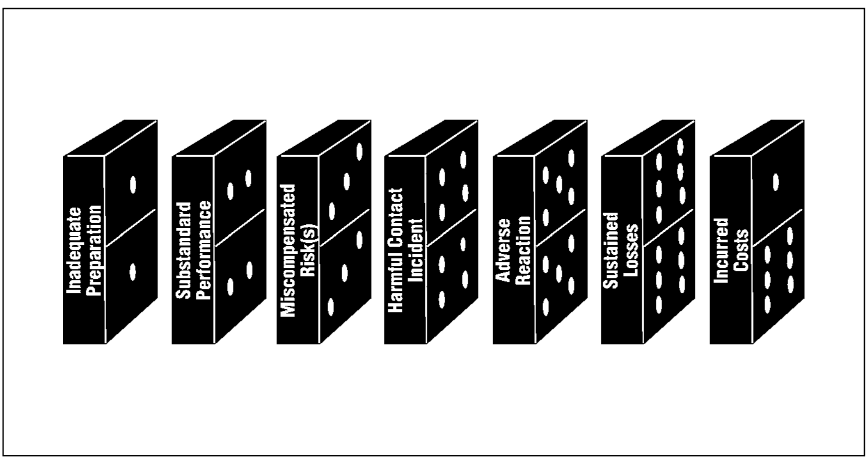
Marcum's Domino Theory

According to C. E. Marcum's 1978 Seven Domino Sequence of Misactsidents, a ***misactsident*** is an identifiable sequence of misacts associated with inadequate task preparation leading to substandard performance and miscompensated risks. The misactsident permits individuals and facilities to come in contact with harmful agents, energy forms, forces, or substances in ways that initiate adverse reactions sufficiently extensive so that unwarranted losses are sustained and resultant costs incurred.

Like the Bird and Loftus theory of accident causation, Marcum's theory focuses on management responsibility for protecting employee safety as well as preventing the downgrading of an organization. Downgrading of an organization includes incurring losses to equipment and facilities and to intangible assets of the organization such as reputation or corporate goodwill. This theory attempts to examine management accident response protocols to ensure that sustained losses and the subsequent incurred costs were minimized. Marcum keeps these two postcontact-phase components separate to permit closer monitoring of the two variables during accident analysis activities. Throughout this theory, Marcum focuses on the human element of misacts. This includes misacts of employees who fail to recognize or appreciate risks in the workplace, as well as misacts of organization management who permit risks to go unrecognized, unappreciated, and/or uncorrected.

Marcum uses the term *misactsidents* to emphasize the deterministic aspects of his accident causation theory. Accidents, Marcum

Figure 5-4. An illustration of Marcum's Theory of Accident Causation.



believes, are considered by most as events occurring by chance. There is no control over them. They may even be considered acts of God. Marcum emphasizes that accidents have specific causes and can be controlled—that safety can and must be managed.

Multiple Causation Accident Theories

Multiple Factors Theory

Manuele (1997a) believes the domino theories are too simplistic. He proposes the term ***unsafe act*** also be eliminated. He suggests the chief culprits in accident causation are less-than-adequate safety policies, standards, and procedures; and inadequate implementation accountability systems. Manuele attempts to pull different causation theories together into one working theory. His approach also incorporates some of the following ideas.

Grose's multiple factors theory uses four Ms to represent factors causing an accident: machine, media, man, and management (Brauer, 1990). ***Machine*** refers to tools, equipment, or vehicles contributing to the cause of an accident. ***Media*** includes the environmental conditions surrounding an accident, such as the weather conditions or walking surfaces. ***Man*** deals with the people and human factors contributing to the incident. ***Management*** also incorporates the other three Ms, looking at the methods used to select equipment, train personnel, or ensure a relatively hazard-free environment.

The multiple factors theory examines characteristics of each of the four Ms:

1. ***Machinery:*** Examination of machinery characteristics includes the design, shape, size, or specific type of energy used to operate the equipment
2. ***Man:*** Characteristics of man are psychological state; gender; age; physiological variables (including height, weight, or condition); and cognitive attributes (such as memory, recall, or knowledge level)
3. ***Media:*** Snow or water on a roadway, temperature of a building, and outdoor temperature can be characteristics of media

4. ***Management:*** Characteristics of management could include safety rules, organizational structure, or policy and procedures

Multiple factors theories attempt to identify specific workplace characteristics that reveal underlying, and often hidden, causes of an accident by pointing to existing hazardous conditions. When viewed as a whole, the characteristics can direct the investigator's attention to the specific causes of an accident.

Systems Theory of Causation

One variation of the Multiple Causation Theory is R. J. Firenzie's Theory of Accident Causation. Firenzie's theory is based on interaction among three components: ***person***, ***machine***, and ***environment***. Human variables of information, decisions, and perception of risks combine with machine hazards and environmental factors affecting the likelihood of an accident.

For example, as a person operates a noisy bulldozer on a hot day, other activities must take place for the operator to safely and effectively perform the job. The person consciously or unconsciously will collect information, weigh risks, and make decisions as to how to perform the task. How close should the bulldozer get to the 20-foot-high spoil bank or the electrical power lines? How fast should it be moving? The operator, based on knowledge and experience, makes countless decisions—all of which affect the probability of an accident.

Psychological/Behavioral Accident Causation Theories

Goals Freedom Alertness Theory

Dr. Willard Kerr's theory of accident causation regards an accident as a low-quality work behavior. He considers it to be similar to production waste during manufacturing, except that the scrap happens to be human. Raising the level of quality and safety involves raising the level of worker awareness. According to Kerr, alertness can only be obtained within a positive organizational culture and psychological climate. The more positive the workplace climate, the greater the alertness and work quality is. As alertness decreases, the probability of an accident rises.

Motivation Reward Satisfaction Model

This theory of accident causation builds on Dr. Willard Kerr's Goals Freedom Alertness Theory and Herzberg's Hygienic Management Theory. Stated simply, the "freedom to set reasonably attainable goals is typically accompanied by higher-quality work performance" (Heinrich, Petersen, and Roos, 1980, p. 44). If an accident occurs, it is due to a lull in alertness. Safety performance depends on degree of motivation and capability to work; factors affecting these variables will either promote or prevent accidents.

According to Petersen, rewards strongly affect performance. They originate from a variety of sources and can be physical and/or psychological. Money or praise is not considered to be the primary motivation factor. Rewards, including doing a good job, learning new skills, expanding personal knowledge, and participating on a successful team, are some of the numerous intrinsic reinforcements associated with enriched jobs. If employees see the rewards from their work as equitable, they are more likely to be motivated and, in turn, produce positive safety results.

Human Factors Theory

The *Human Factors Theory* is based on the concept that accidents are the result of human error. ***Factors that cause human error are:***

- ***Overload: Overload*** occurs when a person is burdened with excessive tasks or responsibilities. For example, the employee not only must perform his or her job, but must also handle excessive noise, stress, personal problems, and unclear instructions.
- ***Inappropriate activities:*** "Inappropriate activities" is another term for human error. When individuals undertake a task without proper training, they are acting inappropriately.
- ***Inappropriate response:*** "Inappropriate response" occurs, for example, when an employee detects a hazardous condition but does

not correct it, or removes a safeguard from a machine to increase productivity.

Overload, inappropriate activities, and inappropriate responses are all human factors causing human error and, ultimately, accidents.

Energy-Related Accident Causation Theories

Energy Release Theory

Accidents result when energy, out of control, puts more stress on a person or property than tolerable without damage. Controlling the energy involved or changing the structures that energy could damage can prevent accidents. William Johnson expanded Haddon's 10 strategies to 12 when they are applied to the accident investigation strategy referred to as Management Oversight and Risk Tree (MORT). ***Johnson's barriers to accident-causing energy include:***

- ***Limit the Energy.*** Example: Limit the amount of flammable or combustible materials that are stored on the shop floor. Use low-voltage equipment
- ***Substitute a safer energy form.*** Example: Use nonasbestos brake pads or select nonflammable or nontoxic solvents
- ***Prevent the build-up.*** Example: Utilize fuses, circuit breakers, and gas detectors
- ***Prevent the release of the energy.*** Example: Attach toe boards on scaffolds to prevent tools from striking people or objects below
- ***Provide for slow release.*** Example: Utilize safety-release valves
- ***Channel the release away; separate it in time or space.*** Example: Ground electrical appliances
- ***Place a barrier on the energy source.*** Example: Place machine guards or utilize acoustic enclosures
- ***Place a barrier between the energy source and the persons or objects to be protected.*** Example: Use rails on elevated surfaces; use fire doors

- ***Place a barrier on the persons or objects to be protected.*** Example: Require personal protective equipment (PPE) and respirators
- ***Raise the injury or damage threshold.*** Example: Acclimatize to a hot or cold work environment
- ***Ameliorate the effects.*** Example: Incorporate administrative controls such as job rotation to reduce the duration of exposure to loud noise
- ***Rehabilitate.*** Example: Treat injured employees or repair damaged objects

Haddon and Johnson focus on energy as the source of the hazard. Identifying energy sources and preventing or minimizing exposures can prevent accidents.

Incident Investigation

Incidents include near misses and accidents. ***Accidents*** result in loss. ***Near misses*** result in no loss. The purpose of any incident investigation is to determine cause(s). As already mentioned, the circumstances differentiating a near miss from a loss-producing incident or accident may be merely a matter of chance; therefore, all incidents can be considered candidates for investigation, since correcting the contributing circumstances may help prevent future incidents.

Incident investigation is concerned with fact-finding, not fault-finding. During the accident investigation, it is important to find out answers to the questions ***who, what, where, when, why,*** and ***how***.

Who questions include:

- Who are the victims?
- Who are the witnesses?
- Who has any information that will help determine the actual causes of the incident?

What questions include:

- What events led up to the accident?
- What were victims and witnesses doing prior to and during the incident?

- What did individuals notice that may have a bearing on the incident?
- What were the backgrounds and experiences of all the parties involved?

When questions include:

- When did the incident occur?
- When did you notice important elements associated with the incident?
- When did you become concerned that a problem existed?

Where questions include:

- Where were victims and witnesses prior to and during the incident?
- Where were equipment and/or machinery?
- Where were the PPE or the locks and tags for energy sources?

Why questions include:

- Why, in your opinion, did the incident take place?
- Why were particular methods used to perform a task?
- Why were these conditions existing at the time of the incident?

How questions include:

- How did the incident take place?
- How did the victims and witnesses react in given situations?
- How did you first learn of the incident?

When an investigation team arrives at the scene, key elements of personnel, tools/equipment, raw materials or finished product, and structure and environment must be searched for possible clues. Systematically consider each as a source of clues and pull those clues together to find likely causes.

Preplanning and preparation are of vital importance. Know roles and responsibilities of each investigator and prepare for prompt arrival at the accident scene so evidence does not disappear or witness recollections are not lost. Ensure all tools and equipment necessary to conduct the investigation are organized and available at all times.

Utilize a checklist to confirm all appropriate individuals are contacted—from the plant manager or corporate CEO to OSHA and EPA officials. Periodic mock drills ensure effective responses to emergencies by highlighting weaknesses. An enterprise was checking its building evacuation plan for the first time and ran a mock drill. When the occupants filled the stairwells, the weight forced the door frames at the base of the stairs onto the doors so they would not open. Had this happened in an emergency, all occupants would have been trapped inside the building. In addition, effective decisions regarding response are more likely to be made during practice than in the heat and scrutiny of a critical investigation. Publicity, time constraints, and political pressures inhibit effective decision making. These factors are less intense and less likely to exist during practice. Standard operating procedures should be developed during mock investigations. The following is a brief protocol of some of the steps that can be followed at a facility to prepare for accident investigations.

When an accident occurs:

1. Notify the following individuals immediately (list important individuals here).
2. Secure the scene to prevent additional accidents; bring in accident-trained technical personnel to determine:
   - Damage to and hazard from power, gas, and fluids distribution systems
   - The structural integrity of the building and equipment
   - The best way to remove or make harmless explosives and/or hazardous materials

Caution: make sure the positions of switches, equipment, and materials are recorded before they are moved or removed.

3. Evaluate the condition of any injured personnel; determine:
   - What is the degree of injury?

- What must be done immediately to save life?
- What should be done to relieve suffering until the injured individual can be removed to a medical facility?
- What can be done to remove all danger of increased injury?

Caution: move an injured person only if there is danger of further injury.

4. Identify the elements at the accident scene:
   - People involved
     - ☐ injured
     - ☐ principals
     - ☐ witnesses
   - Equipment involved
     - ☐ in use
     - ☐ standby
     - ☐ secured or standing
     - ☐ materials involved
     - ☐ in use
     - ☐ ready for use
     - ☐ stored in area
   - Environmental factors
     - ☐ weather
     - ☐ lighting
     - ☐ heat
     - ☐ noise
   - Any additional contributing factors
   - Keep detailed notes for reference
5. Secure the accident scene:
   - Barricade the area to prevent removal or defacement of possible evidence
   - Isolate potential witnesses
6. Collect and preserve the evidence:
   - Make drawings of the area

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- Pick up, store, and label evidence
- If evidence cannot be removed from the scene or it is too large to bag, take pictures or make drawings, making sure to note the location on the drawing of the area
- Make notes of any observations regarding the accident scene

7. Develop witness questions:
   - Form open-ended questions based on initial observations and evidence collected
   - Include control questions to ensure the accuracy of the statistical data and to permit later evaluation of witness reliability
8. Interview the witnesses:
   - Interview each witness separately
   - Find a suitable location
   - Be prepared to take notes on and/or record the interview
   - Take short notes as a memory device
   - If a recording device is used, ask for permission to record before the interview begins
   - Watch for witness cues during the interview
   - Take into account personality types:
     - ☐ introvert
     - ☐ extrovert
     - ☐ suspicious
     - ☐ prejudiced
     - ☐ other personality traits
   - Notice any nonverbal messages:
     - ☐ body language
     - ☐ voice changes
   - Establish initial communication.
   - Assure the individual that the purpose of the interview is for accident prevention, not assigning blame

- Note whether the witness was:
  - ☐ the injured party
  - ☐ an eyewitness
  - ☐ an "ear witness"
- Take an initial statement
- Have the witness describe the incident in his or her own terms
- Avoid interrupting the witness during the statement
- Expand the interview for detail
- Ask the developed open-ended questions
- Space the control questions throughout this portion of the interview
- Close the interview
- Ask the witness for his suggestions on how the accident could have been prevented
- Thank the witness for his or her time
- Evaluate the witness statements
- Develop a witness analysis matrix based on the control questions
- Place the control question numbers on the horizontal axis
- Put the witness statements on the vertical axis
- Place an X in those columns where the witness has accurately answered the control question
- Check credibility of individual testimony based on control questions
- High witness credibility is based on the number of accurate responses to the control questions

Caution: just because a witness gives inaccurate answers to the control questions, it does not totally invalidate his or her testimony.

9. If necessary, conduct follow-up witness interviews:
   - Let the witness know there is a gap or deficiency in a critical area of the investigation.

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- Allow the individual to reconsider or reexamine his or her observations

Caution: be sure to remain nonjudgmental.

10. Synthesize the information gathered from the witnesses interviewed and evidence collected to determine the accident cause
11. Use the data gathered from the accident to perform an accident trend analysis
12. Make changes to operating procedures, equipment, and/or training based on the accident trend analysis

Caution: some interviewers prefer to use audio and/or video equipment to record witness interviews. Interviews may include witness speculations, hearsay, and unfounded conclusions on the part of biased or uninformed individuals. Recordings of those interviews may later be subpoenaed during litigation or criminal hearings. When only notes are taken, speculations can be omitted and signatures can be affixed to statements limited to facts.

Conclusion

Several accident causation models have been presented in this review. The theories focus on people variables, management aspects, and physical characteristics of hazards. The benefit of understanding accident causation is in recognizing how hazards in the workplace result in losses. Eliminating hazards before they result in losses is the proactive responsibility of everyone in an organization. Professionals recognize it is not always possible to identify and eliminate all hazards. Accidents may still occur in spite of a proactive safety program. It is at that point where an effective accident investigation program is of vital importance for the collection of critical data.

Questions

1. What are some of the benefits associated with understanding accident causation theory? Explain your answer.
2. What are the advantages of considering accidents as management problems?
3. What are the two factors associated with risk? Explain how these two factors impact on the selection of accident controls.
4. Is it important to conduct accident investigations? Why?
5. What are the six key questions that should be asked during accident investigations? Explain the importance of these six questions to the health and safety professional.

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