

Occupational Hazard and Control Principles

World Health Organization

- Occupational health deals with all aspects of health and safety in the workplace and has a strong focus on **primary prevention of hazards**
- **Health** has been defined as -a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity
- Occupational health is a multidisciplinary field of healthcare concerned with enabling an individual to undertake their occupation, in the way that causes least harm to their health.

- The **safety movement** in the United States has developed steadily since the early 1900s.
- In that time period, industrial accidents were commonplace in this country; for example, in 1907, more than 3,200 people were killed in mining accidents.
- Legislation, precedent, and public opinion all favored management. There were few protections for workers' safety.

Change over the past three decades

Some of the more prominent reasons include the following:

- Technological changes that have introduced new hazards in the workplace;
- Proliferation of health and safety legislation and corresponding regulations;
- Increased pressure from regulatory agencies;
- Realization by executives that workers in a safe and healthy workplace are typically more productive or else compensation cost increases;
- Increased pressure from environmental groups and the public;
- A growing interest in ethics and corporate responsibility;
- Professionalization of health and safety occupations;
- Increased pressure from labor organizations and employees in general;
- Rapidly mounting costs associated with product safety and other types of litigation;
- Increasing incidents of workplace violence.

Definitions

- **Ergonomics:** is the process of designing or arranging workplaces, products and systems so that they fit the people who use them.
- **Safety:** Safety can be defined as the freedom from those conditions that can cause injury or death, to personnel or damage or loss of equipment's and property
- **Injury:** It can be defined as a harmful condition sustained by the body as a result of an accident. An injury can takes place in the form of an abrasion fracture in the body.
- **Hazard:** It is an inherent property of a substance to cause harmful effect to a living being or to a property or environment.

Definitions

- **Risk:** It is a probability the realization of the potential for loss, damage or injury
- **Accident:** It is an unplanned or unexpected event which causes or likely to cause injury to a person, damage to property

Safety and **health**

- Safety and **health**, although closely related, are not the same.
- One view is that safety is concerned with injury-causing situations, **whereas health is concerned with disease causing conditions.**
- Another view is that safety is concerned with hazards to humans that result from sudden severe conditions; **health deals with adverse reactions to prolonged exposure to dangerous, but less intense, hazards**

- on the one hand, **stress** is a hazard that can cause both psychological and physiological problems over a prolonged period.
- In this case, it is a **health** concern.
- On the other hand, an overly stressed worker may be more prone to unintentionally forget safety precautions and thus may cause an accident.
- In this case, **stress** is a **safety** concern.

HISTORY

**DEVELOPMENTS BEFORE THE
INDUSTRIAL REVOLUTION**

- The continuum begins with the days of the ancient Babylonians.
- During that time, circa 2000 BC, their ruler, Hammurabi, developed his

“Code of Hammurabi”

- The code encompassed all the laws of the land at that time, showed Hammurabi to be a just ruler, and set a precedent followed by other Mesopotamian kings.
- The significance of the code from the perspective of safety and health is that it contained clauses dealing with **injuries, allowable fees for physicians, and monetary damages** assessed against those who injured others.
- This clause from the code illustrates Hammurabi’s concern for the proper handling of injuries:

“If a man has caused the loss of a gentleman’s eye, his own eye shall be caused to be lost”

- This movement continued and emerged in later Egyptian civilization.
- As evidenced from the temples and pyramids that still remain, the Egyptians were an industrious people.

The Code Of Hammurabi

- The Code of Hammurabi was the first laws system created in the Middle East civilization.
- The laws were written in stone and was placed in a public location so everyone can take a look at the 282 laws that the citizens should be obeyed.
- The laws might seem hard by today's standards, but Hammurabi created those laws because he wants everyone to be responsible for their own actions and Hammurabi wanted the citizens all to be fair.
- The original stone is located now in the Louvre Museum in France.



- During the reign of **Rameses II** (circa 1500 BC), he undertook a major construction project, the Ramesseum.
- To ensure the maintenance of a workforce sufficient to build this huge temple bearing his name, Rameses created an **industrial medical service** to care for the workers.
- They were required to bathe daily in the Nile and were given regular medical examinations.
- Sick workers were isolated.
- The Romans were vitally concerned with safety and health, as can be seen from the remains of their construction projects.
- The Romans built aqueducts, sewerage systems, public baths, latrines, and well-ventilated houses



- **Ramesseum**, funerary temple of Ramses II (1279–13 bc), erected on the west bank of the Nile River at Thebes in Upper Egypt. The temple, famous for its 57-foot (17-metre) seated statue of Ramses II (of which only fragments are left), was dedicated to the god Amon and the deceased ...

- As civilization progressed, so did safety and health developments.
- In 1567, **Philippus Aureolus** produced a treatise on the **pulmonary diseases** of miners.
- Titled *On the Miners' **Sickness and Other Miners' Diseases***, the treatise covered diseases of smelter workers and metallurgists and diseases associated with the handling of and exposure to mercury.
- Around the same time, **Georgius Agricola** published his treatise ***De Re Metallica***, emphasizing the need for ventilation in mines and illustrating various devices that could be used to introduce fresh air into mines

Coal Mine Dust Lung Disease

➤ caused by inhalation of coal mine dust and the body's reaction to it

1. Fibrotic diseases - damage/destroy lung tissue

- Coal workers' pneumoconiosis "CWP"
- Silicosis
- Mixed dust pneumoconiosis
- Dust-related diffuse fibrosis

2. Airflow diseases - block movement of air

- Bronchitis
- Emphysema
- Mineral dust small airway disease "COPD"

3. Infectious diseases - dust reduces immunity

- Tuberculosis/related

- The eighteenth century saw the contributions of Bernardino **Ramazzini**, who wrote *Discourse on the Diseases of Workers*.
- Ramazzini drew conclusive parallels between diseases suffered by workers and their occupations.
- He related occupational diseases to the handling of harmful materials and to irregular or unnatural movements of the body.
- Much of what Ramazzini wrote is still relevant today.



BERNARDINO RAMAZZINI
From the *Opera Omnia*, Genova, 1717.

DE MORBIS ARTIFICUM
BERNARDINI RAMAZZINI
DIATRIBA

DISEASES OF WORKERS

The Latin text of 1713
Revised, with translation and notes

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1940

- The Industrial Revolution changed forever the methods of producing goods.
- According to J. LaDou, the changes in production brought about by the Industrial Revolution can be summarized as follows:
- Introduction of **inanimate power** (i.e., steam power) to replace people and animal power
- Substitution of machines for people
- Introduction of new methods for converting raw materials
- Organization and specialization of work, resulting in a division of labor



MILESTONES IN THE SAFETY MOVEMENT

- Following an outbreak of fever among the children working in their cotton mills, the people of Manchester, England, began demanding better working conditions in the factories.
- Public pressure eventually forced a government response, and in **1802 the Health and Morals of Apprentices Act** was passed.
- This was a milestone piece of legislation
- It marked the beginning of governmental involvement in workplace safety.

- When the industrial sector began to grow in the United States, hazardous working conditions were commonplace.
- The seeds of the safety movement were sown in this country.
- Factory inspection was introduced in Massachusetts in 1867.
- In 1868, the first barrier safeguard was patented.
- In 1869, the Pennsylvania legislature passed a mine safety law requiring two exits from all mines.
- The Bureau of Labor Statistics (BLS) was established in 1869 to study industrial accidents and report pertinent information about those accidents.

- In 1892, the first recorded safety program was established in a Joliet, Illinois, steel plant in response to a scare caused when a flywheel exploded.
- In 1907, the U.S. Department of the Interior created the Bureau of Mines to investigate accidents, examine health hazards, and make recommendations for improvements.
- 1908 **workers' compensation** was introduced in the United States

- The Association of Iron and Steel Electrical Engineers (AISEE), formed in the early 1900s, pressed for a national conference on safety.
- As a result of the AISEE's efforts, the first meeting of the **Cooperative Safety Congress (CSC)** took place in Milwaukee in 1912.
- What is particularly significant about this meeting is that it planted the seeds for the eventual establishment of the NSC.
- A year after the initial meeting of the CSC, the **National Council of Industrial Safety (NCIS)** was established in Chicago. In 1915, this organization changed its name to the National Safety Council.
- It is now the premier safety organization in the United States.

- The 1960s saw the passage of a flurry of legislation promoting workplace safety.
- The Service Contract Act of 1965, the Federal Metal and Nonmetallic Mine Safety Act, the Federal Coal Mine and Safety Act, and the Contract Workers and Safety Standards Act all were passed during the 1960s.

- *The state legislated safety requirements only in specific industries, had inadequate safety and health standards, and had inadequate budgets for enforcement. . . . The injury and death toll due to industrial mishaps was still . . . too high.*
- *In the late 1960s, more than 14,000 employees were killed annually in connection with their jobs. . . . Work injury rates were taking an upward swing.*

These were the primary reasons behind passage of the Occupational Safety and Health Act (OSH Act) of 1970 and the Federal Mine Safety Act of 1977

- The Superfund Amendments and Reauthorization Act was passed by Congress in 1986,
- Clean Air Act in 1990;
- The concept of Total Safety Management (TSM) was introduced in 1996 to help safety professionals working in organizations that subscribe to the Total Quality Management (TQM) philosophy and/or that pursue ISO 9000 registration.

National Safety Policy

Government of India

Ministry of Labour and Employment

The Directive Principles provided

- for securing the **health** and **strength** of employees, men and women;
- that the **tender age** of children are not abused;
- that citizens are not forced by economic necessity to enter avocations unsuited to their age or strength;
- just and humane conditions of **work** and **maternity** relief are provided; and
- that the Government shall take steps, by suitable legislation or in any other way, to secure the participation of employee in the management of undertakings, establishments or other organisations engaged in any industry.

GOALS

The Government firmly believes that building and maintaining national preventive safety and health culture is the need of the hour.

With a view to develop such a culture and to improve the safety, health and environment at work place, it is essential to meet the following requirements:-

- providing a statutory framework on Occupational Safety and Health in respect of all sectors of industrial activities including the **construction sector, designing suitable control systems of compliance, enforcement and incentives** for better compliance.
- providing **administrative and technical** support services.
- providing a system of **incentives to employers and employees** to achieve higher health and safety standards .
- establishing and developing the **research and development** capability in emerging areas of risk and providing for effective control measures.

- Focusing on **prevention strategies and monitoring performance** through improved data collection system on work related injuries and diseases.
- Developing and providing required **technical manpower and knowledge** in the areas of safety, health and environment at workplaces in different sectors.
- Promoting inclusion of safety, health and environment, improvement at workplaces as an important component in other relevant national policy documents.
- Including safety and occupational health as an integral part of every operation.

OBJECTIVES

- Continuous **reduction** in the incidence of work related injuries, fatalities, diseases, disasters and loss of national assets.
- **Improved coverage** of work related injuries, fatalities and diseases and provide for a more comprehensive data base for facilitating better performance and monitoring.
- Continuous enhancement of **community awareness** regarding safety, health and environment at workplace related areas.
- Continually increasing **community expectation** of workplace health and safety standards.
- Improving safety, health and environment at workplace by creation of **“green jobs”** contributing to sustainable enterprise development.

ACTION PROGRAMME

- by providing an effective enforcement **machinery** as well as suitable provisions for compensation and rehabilitation of affected persons;
- by effectively enforcing all applicable **laws and regulations** concerning safety, health and environment at workplaces in all economic activities through an adequate and effective labour inspection system;
- By establishing **suitable schemes** for subsidy and provision of **loans** to enable effective implementation of the policy;
- by ensuring that employers, employees and others have separate but **complementary responsibilities and rights** with respect to achieving safe and healthy working conditions;

- by **amending expeditiously existing laws** relating to safety, health and environment and bring them in line with the relevant international instruments;
- by monitoring the **adoption of national standards** through regulatory authorities;
- by facilitating the **sharing of best practices and experiences** between national and international regulatory authorities;
- by developing **new and innovative enforcement methods** including financial incentives that encourage and ensure improved workplace performance;
- by making an **enabling legislation** on Safety, Health and Environment at Workplaces;
- by setting up safety and health **committees** wherever deemed appropriate;

Occupational Safety and Health Act (OSH Act) of 1970

Congress passed the OSH Act with the following stated purpose:

“To assure so far as possible every working man and woman in the nation safe and healthful working conditions and to preserve our human resources.”

Rationale (Reasons)

According to the U.S. Department of Labor, in developing this comprehensive and far-reaching piece of legislation, Congress considered the following statistics:

- Every year, an average of 14,000 deaths was caused by **workplace accidents**.
- Every year, 2.5 million workers were disabled in workplace accidents.
- Every year, approximately 300,000 new cases of **occupational diseases** were reported.

OSHA'S MISSION AND PURPOSE

- Encourage employers and employees to reduce workplace hazards.
- Implement new safety and health programs.
- Improve existing safety and health programs.
- Encourage research that will lead to innovative ways of dealing with workplace safety and health problems.
- Establish the rights of employers regarding the improvement of workplace safety and health.
- Establish the rights of employees regarding the improvement of workplace safety and health.

Cont'd...

- Monitor job-related illnesses and injuries through a system of reporting and record keeping.
- Establish training programs to increase the number of safety and health professionals and to improve their competence continually.
- Establish mandatory workplace safety and health standards and enforce those standards.
- Provide for the development and approval of state-level workplace safety and health programs.
- Monitor, analyze, and evaluate **state-level safety and health programs**

OSH ACT COVERAGE

- The OSH Act applies to most employers.
- If an organization has even one employee, it is considered an employer and must comply with applicable sections of the act.
- This includes all types of employers from manufacturing and construction to retail and service organizations.
- There is no exemption for small businesses, although organizations with 10 or fewer employees are exempted from OSHA inspections and the requirement to maintain injury and illness records.

- Although the OSH Act is the most comprehensive and far-reaching piece of safety and health legislation ever passed in this country, it does not cover all employers.
- In general, the OSH Act covers employers in all 50 states, the District of Columbia, Puerto Rico, and all other territories that fall under the jurisdiction of the U.S. government.

Exempted employers are

- Persons who are self-employed
- Family farms that employ only immediate members of the family
- Federal agencies covered by other federal statutes (in cases where these other federal
- statutes do not cover working conditions in a specific area or areas, OSHA standards apply)
- State and local governments (except to gain OSHA's approval of a state-level safety and health plan, states must provide a program for state and local government employees that is at least equal to its private sector plan)
- Coal mines (coal mines are regulated by mining-specific laws)

Right to know laws and SARA III 1886

- Hazard communication laws known as right to know laws act
- The best act proposed by OSHA is a hazard communication standard enacted in 1983
- This standard involves assessment of hazard by the company to inform the workers about hazard and train them for safe handling

- The EPA has also involved with right to know laws as a result of Super Fund Amendment and Reauthorization act 1986 (SARA III)
- This act requires company's to provide authorities with information concerning toxic chemical releases
- SARA III also encourages emergency planning in response to incidence due to material handling

Right to know laws act: Objectives

- Dangerous properties of material used or produced in the work place are determined
- Employees are to be trained in the organization for safe handling of those material
- The laws force compliance to disclose the presence of HS

Steps according to SARA III

- Hazard determination
- The written programme
- Training

Material safety data sheet

- It is the key to communication and compliance to right to know laws
- Description about physical, chemical and other properties
- Chemical name o common name of material
- Vapour pressure and flash point
- Potential for fire, explosion and reactivity
- Health concern and medical condition
- Precaution for safe handling and use including procedure for cleaning wok area

The written program

- It helps in developing, implementing and maintaining hazard communication programme
- It should even describe the location of hazardous substance
- Labeling procedure

Training

- To employees and employers
- Describes the importance of MSDS

OSHA requirements

- There are many to which employers must adhere.
- Some apply to all employers—except those exempted—whereas others apply only to specific types of employers.

These requirements cover areas of concern such as the following:

- Fire protection
- Electricity
- Sanitation
- Air quality
- Machine use, maintenance, and repair
- Posting of notices and warnings
- Reporting of accidents and illnesses
- Maintaining written

Organised labour

- **Organized labor** has played a crucial role in the development of the safety movement
- Organized labor has fought for safer working conditions and appropriate compensation for workers injured on the job.
- Many of the earliest developments in the safety movement were the result of long and hard-fought battles by organized labor.

- Among the most important contributions of organized labor to the safety movement was their work to overturn antilabor laws relating to safety in the workplace.
- These laws were the fellow servant rule, the statutes defining contributory negligence, and the concept of assumption of risk.
- The **fellow servant rule** held that employers were not liable for workplace injuries that resulted from the negligence of other employees.
- For example,
- if Worker X slipped and fell, breaking his back in the process, because Worker Y spilled oil on the floor and left it there, the employer's liability was removed.
- In addition, if the actions of employees contributed to their own injuries, the employer was absolved of any liability. This was the doctrine of **contributory negligence**.

- The concept of **assumption of risk** was based on the theory that people who accept a job assume the risks that go with it.
- It says employees who work voluntarily should accept the consequences of their actions on the job rather than blame the employer.
- Organized labor played a crucial role in bringing deplorable working conditions to the attention of the general public.
- Public awareness and, in some cases, outrage eventually led to these **employer-biased laws** being overturned in all states

DEVELOPMENT OF ACCIDENT PREVENTION PROGRAMS

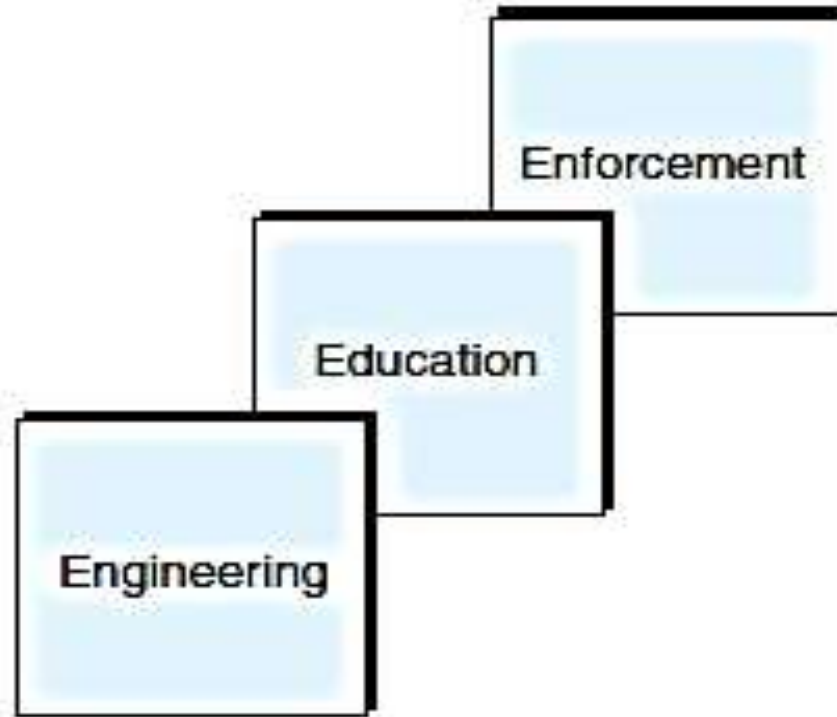
- In the modern workplace, there are many different types of **accident prevention** programs ranging from the simple to the complex.
- Widely used accident prevention techniques include failure minimization, fail-safe designs, isolation, lockouts, screening, personal protective equipment, redundancy, timed replacements, and many others.
- These techniques are individual components of broader safety programs.
- Such programs have evolved since the late 1800s.

Industry began to realize the following:

- Improved engineering could prevent accidents.
- Employees were willing to learn and accept safety rules.
- Safety rules could be established and enforced.
- Financial savings from safety improvement could be reaped by savings in compensation and medical bills

Safety programs were based on the **three E's of safety**:

1. Engineering,
2. Education,
3. Enforcement



- The **engineering aspects** of a safety program involve making design improvements to both product and process. By altering the design of a product, the processes used to manufacture it can be simplified and, as a result, made less dangerous.
- In addition, the manufacturing processes for products can be engineered in ways that decrease potential hazards associated with the processes.
- The **education aspect** of a safety program ensures that employees know how to work safely, why it is important to do so, and that safety is expected by management. Safety education typically covers the what, when, where, why, and how of safety.
- The **enforcement aspect** of a safety program involves making sure that employees abide by safety policies, rules, regulations, practices, and procedures. Supervisors and fellow employees play a key role in the enforcement aspects of modern safety programs.

- Today, the NSC is the largest organization in the United States devoted solely to safety and health practices and procedures. Its purpose is to prevent the losses, both direct and indirect, arising out of accidents or from exposure to unhealthy environments.
- The **Occupational Safety and Health Administration (OSHA)** is the government's administrative arm for the Occupational Safety and Health Act (OSH Act).
- Formed in 1970, OSHA sets and revokes safety and health standards, conducts inspections, investigates problems, issues citations, assesses penalties, petitions the courts to take appropriate action against unsafe employers, provides safety training, provides injury prevention consultation, and maintains a database of health and safety statistics

- Another governmental organization is the **National Institute for Occupational Safety and Health (NIOSH)**.
- This organization is part of the Centers for Disease Control and Prevention (CDC) of the Department of Health and Human Services. NIOSH is required to publish annually a comprehensive list of all known toxic substances.
- NIOSH will also provide on-site tests of potentially toxic substances so that companies know what they are handling and what precautions to take.

Accident – causation, investigation,
investigation plan, Methods of acquiring
accident facts, Supervisory role in accident
investigation

“It is an unplanned or unexpected event which causes or likely to cause injury to a person, damage to property”

Work accident costs and rates

- Workplace accidents cost employers millions every year.
- Consider the following examples from the recent past.
- Arco Chemical Company was ordered to pay \$3.48 million in fines as a result of failing to protect workers from an explosion at its petrochemical plant in Channelview, Texas
- These examples show the costs of fines only.
- In addition to fines, these employers incurred costs for safety corrections, medical treatment, survivor benefits, death and burial costs, and a variety of indirect costs.

Clearly, work accidents are expensive

- Work **accident rates** in this century are evidence of the success of the safety movement in the United States.
- As the amount of attention given to workplace safety and health has increased, the accident rate has decreased.
- According to the NSC, Between 1912 and 1998, accidental work deaths per 100,000 population were reduced 81 percent, from 21 to 4. In 1912, an estimated 18,000 to 21,000 workers' lives were lost.
- In 1998, in a workforce more than triple in size and producing 11 times the goods and services, there were approximately 10,000 work deaths.⁴

WORK INJURIES BY TYPE OF ACCIDENT

Work injuries can be classified by the type of accident from which they resulted.

The most common causes of work injuries are

- Overexertion
- Impact accidents
- Falls
- Bodily reaction (to chemicals)
- Compression
- Motor vehicle accidents
- Exposure to radiation or caustics
- Rubbing or abrasions
- Exposure to extreme temperatures

When death rates are computed on the basis of the number of deaths per 100,000 workers in a given year, the industry categories rank as follows (from highest death rate to lowest):

- Mining/quarrying
- Agriculture
- Construction
- Transportation/public utilities
- Government
- Manufacturing
- Services
- Trade

The most frequent injuries to specific parts of the body are as follows (from most frequent to least):

1. Back
2. Legs and fingers
3. Arms and multiple parts of the body
4. Trunk
5. Hands
6. Eyes, head, and feet
7. Neck, toes, and body systems

Accident causation theory's

- Domino Theory of Accident Causation
- Human Factors Theory of Accident Causation
- Accident/Incident Theory of Accident Causation
- Epidemiological Theory of Accident Causation
- Systems Theory of Accident Causation
- Combination Theory of Accident Causation
- Behavioral Theory of Accident Causation
- Drugs and Accident Causation
- Depression and Accident Causation
- Management Failures and Accident Causation
- Obesity and Accident Causation

Domino Theory of Accident Causation

- An early pioneer of accident prevention and industrial safety was Herbert W. Heinrich, an official with the Travelers Insurance Company.
- In the late 1920s, after studying the reports of 75,000 industrial accidents, Heinrich concluded that 88 percent of industrial accidents are caused by unsafe acts committed by fellow workers.
- 10 percent of industrial accidents are caused by unsafe conditions.
- 2 percent of industrial accidents are unavoidable

Heinrich's study laid the foundation for his *Axioms of Industrial Safety* and his theory of accident causation, which came to be known as the **domino theory**.

Heinrich's Axioms of Industrial Safety

10 statements he called **Axioms of Industrial Safety**

1. Injuries result from a completed series of factors, one of which is the accident itself.
2. An accident can occur only as the result of an unsafe act by a person and/or a physical or mechanical hazard.
3. Most accidents are the result of unsafe behavior by people.
4. An unsafe act by a person or an unsafe condition does not always immediately result in an accident/injury.
5. The reasons why people commit unsafe acts can serve as helpful guides in selecting corrective actions.

6. The severity of an accident is largely fortuitous, and the accident that caused it is largely preventable.
7. The best accident prevention techniques are analogous with the best quality and productivity techniques.
8. Management should assume responsibility for safety because it is in the best position to get results.
9. The supervisor is the key person in the prevention of industrial accidents.
10. In addition to the direct costs of an accident (for example, compensation, liability claims, medical costs, and hospital expenses), there are also hidden or indirect costs.

According to Heinrich, there are five factors in the sequence of events leading up to an accident.

1. **Ancestry and social environment.** Negative character traits that may lead people to behave in an unsafe manner can be inherited (**ancestry**) or acquired as a result of the **social environment**.
2. **Fault of person.** Negative character traits, whether inherited or acquired, are why people behave in an unsafe manner and why hazardous conditions exist.
3. **Unsafe act/mechanical or physical hazard.** **Unsafe acts** committed by people and **mechanical** or **physical hazards** are the direct causes of accidents.
4. **Accident.** Typically, accidents that result in injury are caused by falling or being hit by moving objects.
5. **Injury.** Typical injuries resulting from accidents include lacerations and fractures

Heinrich's theory has two central points:

- (1) injuries are caused by the action of **preceding factors** and
- (2) removal of the **central factor** (unsafe act/**hazardous condition**) negates the action of the preceding factors and, in so doing, prevents accidents and injuries.

HUMAN FACTORS THEORY OF ACCIDENT CAUSATION

The human factors theory of accident causation attributes accidents to a **chain of events** ultimately caused by **human error**.

It consists of the following three broad factors that lead to human error:

- **Overload**
- **inappropriate response**
- **inappropriate activities**

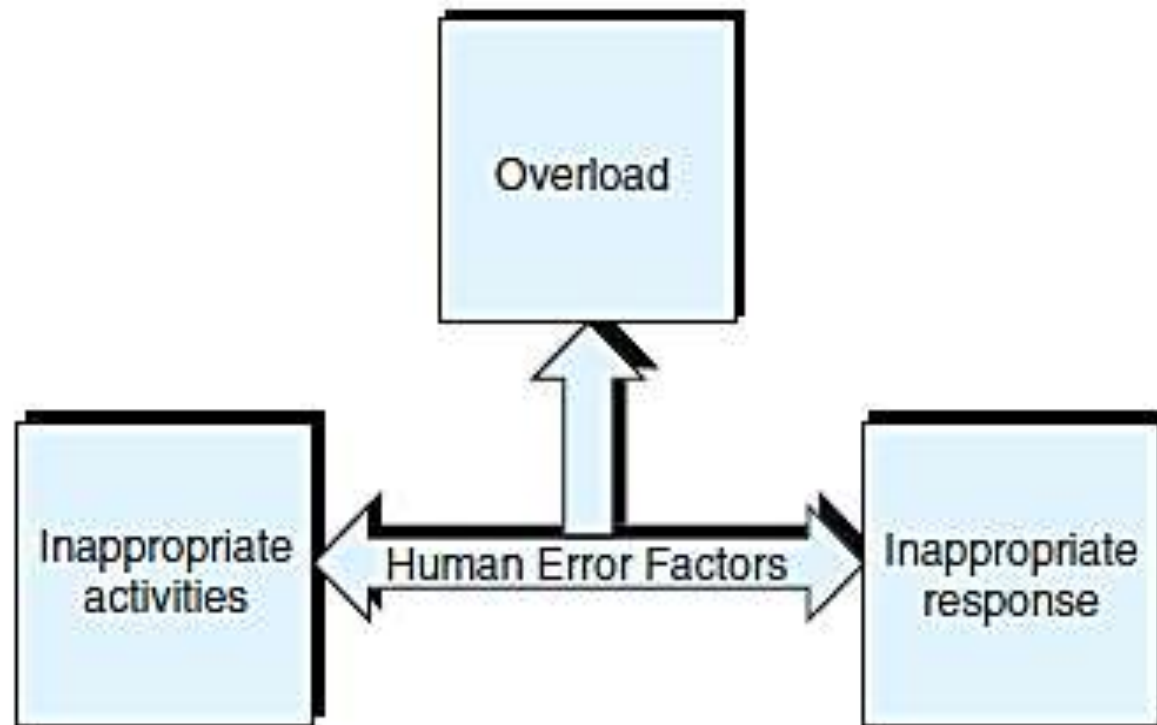


Figure 3–1
Factors that cause human errors.

Overload

Overload amounts to an imbalance between a **person's capacity** at any given time and the **load** that person is carrying in a given state.

A person's capacity is the product of factors such as

- his or her natural ability,
- training,
- state of mind,
- fatigue,
- stress, and
- Physical condition.

The load that a person is carrying consists of tasks for which he or she is responsible and added burdens resulting from

- **environmental factors** (noise, distractions, and so on),
- **internal factors** (personal problems, emotional stress, and worry), and
- **situational factors** (level of risk, unclear instructions, and so on).

Inappropriate Response and Incompatibility

- How a person **responds** in a given **situation** can cause or prevent an accident.

Eg:

- If a person detects a hazardous condition but does **nothing** to correct it, he or she has responded inappropriately.
- If a person **removes a safeguard** from a machine in an effort to increase output, he or she has responded inappropriately.
- If a person disregards an established safety procedure, he or she has responded inappropriately. Such responses can **lead to accidents**.
- In addition to **inappropriate responses**, this component includes workstation **incompatibility**.
- The incompatibility of a person's workstation with regard to size, force, reach, feel, and similar factors can lead to accidents and injuries.

Inappropriate Activities

- Human error can be the result of **inappropriate activities**.
- An example of an inappropriate activity is a person who undertakes a task that he or she **doesn't know how to do**.
- Another example is a person who **misjudges the degree of risk** involved in a given task and proceeds based on that misjudgment.
- Such inappropriate activities can lead to accidents and injuries

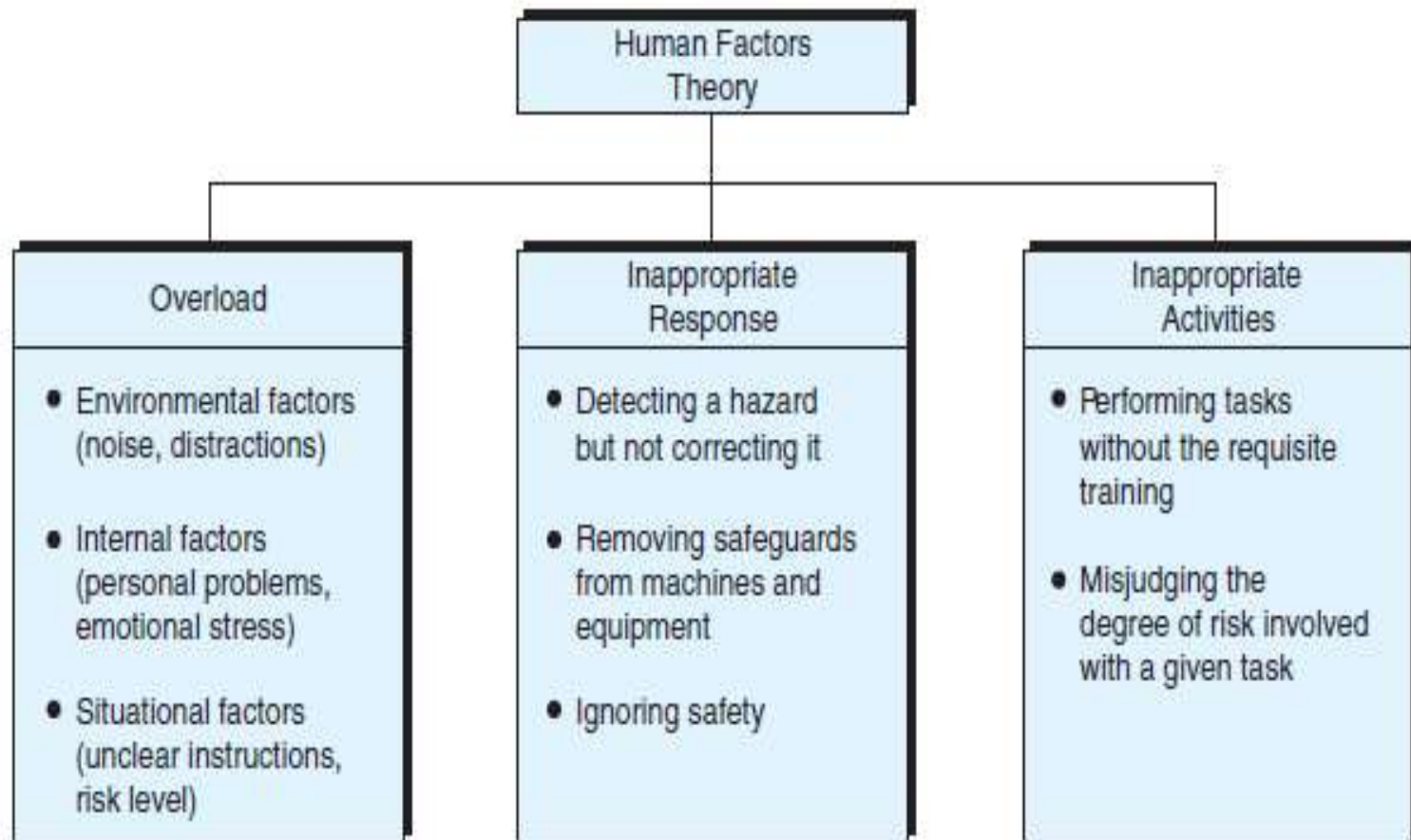


Figure 3–2
Human factors theory.

Kitchenware Manufacturing Incorporated (KMI) produces aluminum kitchenware for commercial settings.

After 10 years of steady, respectable growth in the U.S. market, KMI suddenly saw its sales triple in less than six months.

ACCIDENT/INCIDENT THEORY OF ACCIDENT CAUSATION

The **accident/incident theory** is an extension of the human factors theory. It was developed by **Dan Petersen** and is sometimes referred to as the Petersen accident/incident theory.

Petersen introduced such new elements as **ergonomic traps**, the decision to err, and systems failures, while retaining much of the human factors theory

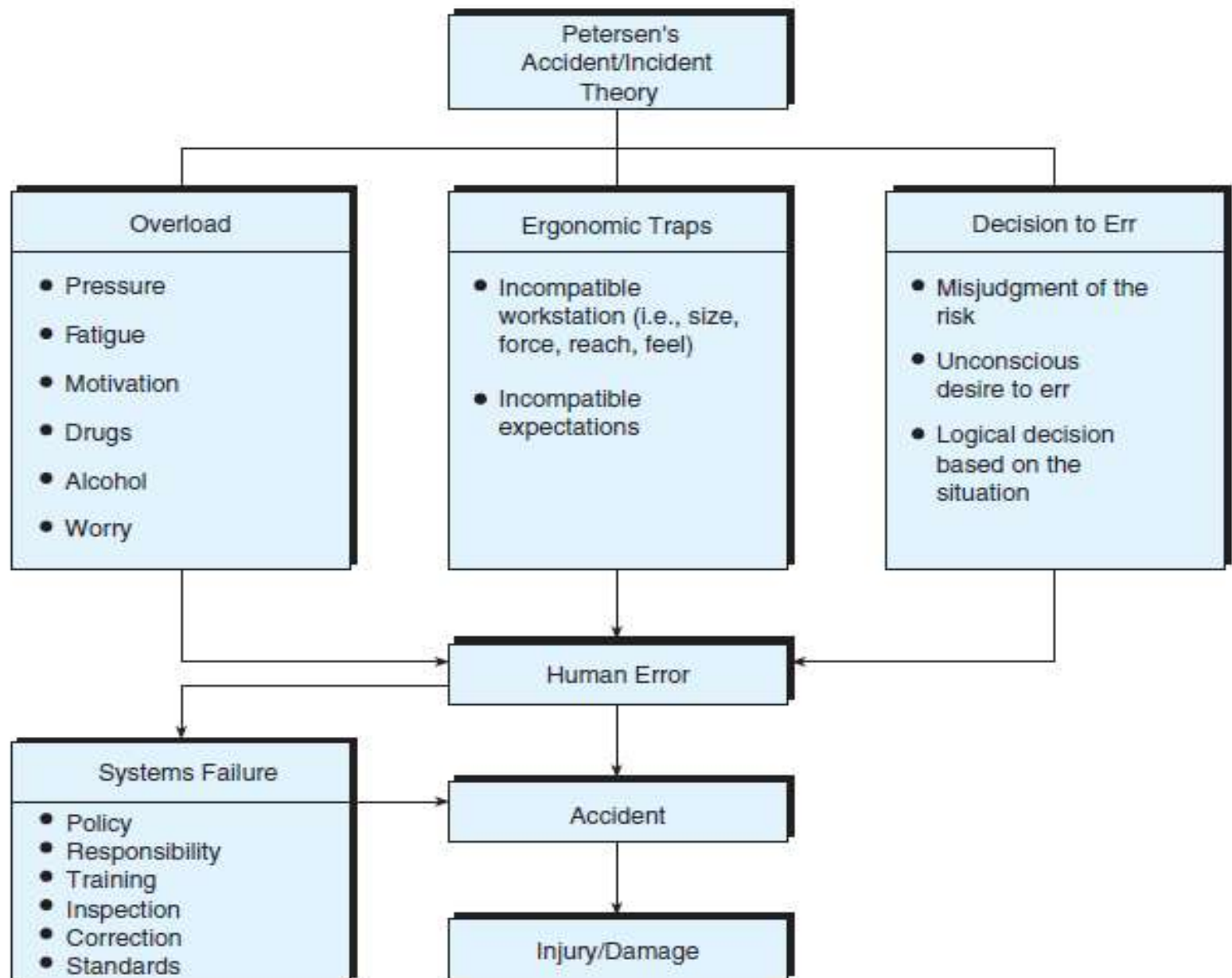


Figure 3–3
Accident/incident theory.

In this model,

- **overload,**
- **ergonomic traps, or**
- **a decision to err lead to human error.**
- The decision to err may be conscious and based on logic, or it may be unconscious.
- A variety of pressures such as deadlines, peer pressure, and budget factors can lead to **unsafe behavior.**
- Another factor that can influence such a decision is the “**It won’t happen to me**” syndrome.

The systems failure component is an important contribution of Petersen’s theory.

- **First,** it shows the potential for a **causal relationship** between management decisions or management behavior and safety.
- **Second,** it establishes management’s role in accident prevention as well as the broader concepts of safety and health in the workplace.

EPIDEMIOLOGICAL THEORY OF ACCIDENT CAUSATION

- Safety theories and programs have focused on accidents and the resulting injuries.
- The current trend is toward a broader perspective that also encompasses the issue of industrial hygiene.

Industrial hygiene concerns environmental factors that can lead to sickness, disease, or other forms of impaired health.

- This trend has, in turn, led to the development of an epidemiological theory of accident causation.

Epidemiology is the study of causal relationships between environmental factors and disease.

The **epidemiological theory** holds that the models used for studying and determining these relationships can also be used to study causal relationships between environmental factors and accidents or diseases

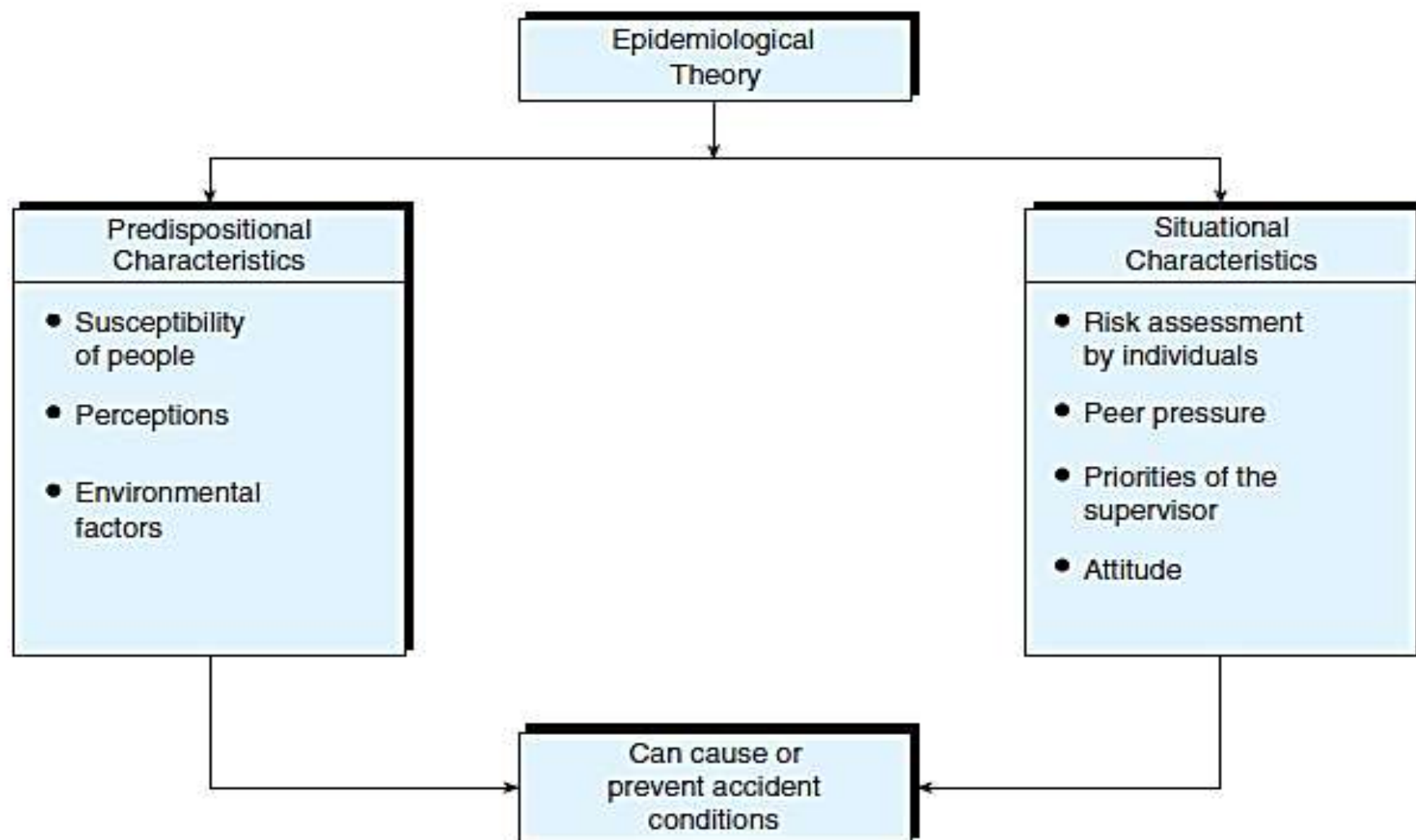


Figure 3–4
Epidemiological theory.

- The key components are **predispositional characteristics** and **situational characteristics**.
- These characteristics, taken together, can either result in or prevent conditions that may result in an accident.
- For example, if an employee who is particularly susceptible to peer pressure (predispositional characteristic) is pressured by his coworkers (situational characteristic) to speed up his operation, the result will be an increased probability of an accident.

SYSTEMS THEORY OF ACCIDENT CAUSATION

- A *system* is a group of regularly interacting and interrelated components that together form a unified whole.
- This definition is the basis for the **systems theory** of accident causation.
- This theory views a situation in which an accident may occur as a system comprised of the following components: **person (host), machine (agency), and environment.**
- The likelihood of an accident occurring is determined by how these components interact.
- Changes in the patterns of interaction can increase or reduce the probability of an accident.

For example,

- an experienced employee who operates a numerically controlled five axis machining center in a shop environment may take a two-week vacation.
- Her temporary replacement may be less experienced.
- This change in one component of the system (person/host) increases the probability of an accident

The primary components of the systems model are the person/machine/environment, information, decisions, risks, and the task to be performed.¹¹ Each of the components has a bearing on the probability that an accident will occur. The systems model is illustrated in Figure 3-5.

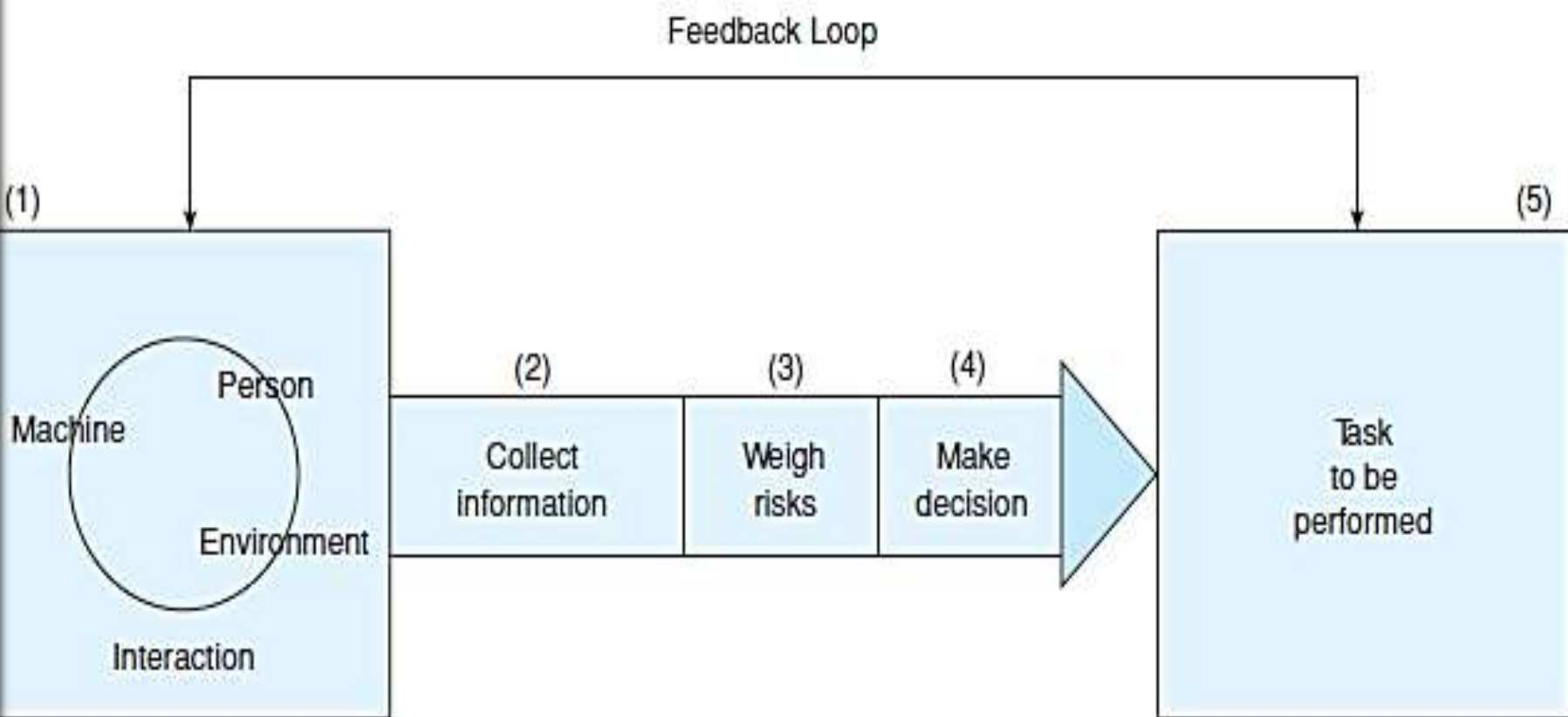


Figure 3-5
Systems theory model.

- As this model shows, even as a person interacts with a machine within an environment, three activities take place between the system and the task to be performed.
- Every time a task must be performed, there is the risk that an accident may occur.
- Sometimes the risks are great; at other times, they are small.
- This is where information collection and decision making come in

- Based on the information that has been collected by **observing** and **mentally noting** the current circumstances, the person **weighs the risks** and **decides** whether to perform the task under existing circumstances.
- **For example, say a machine operator is working on a rush order that is behind schedule. An important safety device has malfunctioned on his machine. Simply taking it off will interrupt work for only five minutes, but it will also increase the probability of an accident. However, replacing it could take up to an hour. Should the operator remove the safety guard and proceed with the task or take the time to replace it?**
- The operator and his supervisor may assess the situation (collect information), weigh the risks, and make a decision to proceed. If their information was right and their assessment of the risks accurate, the task will probably be accomplished without an accident.

- The environment in which the machine operator is working is unusually **hectic**, and the **pressure to complete** an order that is already behind schedule is intense.
- These factors are **stressors** that can cloud the judgment of those collecting information, weighing risks, and making the decision.
- When stressors are introduced between points 1 and 3 in, the likelihood of an accident increases.

For this reason, five factors should be considered before beginning the process of collecting information, weighing risks, and making a decision:

- Job requirements
- The workers' abilities and limitations
- The gain if the task is successfully accomplished
- The loss if the task is attempted but fails
- The loss if the task is not attempted

COMBINATION THEORY OF ACCIDENT CAUSATION

- There is often a degree of difference between any theory of accident causation and reality.
- According to the **combination theory**, the actual cause may combine parts of several different models.
- Safety personnel should use these theories as appropriate both for accident prevention and accident investigation.
- However, they should avoid the tendency to try to apply one model to all accidents.

BEHAVIORAL THEORY OF ACCIDENT CAUSATION

- The behavioral theory of accident causation and prevention is often referred to as **behavior-based safety (BBS)**.
- BBS has both proponents and critics.
- One of the most prominent proponents of BBS is E. Scott Geller, a senior partner of Safety Performance Solutions, Inc., and a professor of psychology.
- It is appropriate that Geller is a professional psychologist because BBS is the application of behavioral theories from the field of psychology to the field of occupational safety.

According to Geller, there are seven basic principles of BBS:

- (1) intervention that is focused on employee behavior;
- (2) identification of external factors that will help understand and improve employee behavior (from the perspective of safety in the workplace);
- (3) direct behavior with activators or events antecedent to the desired behavior, and motivation of the employee to behave as desired with incentives and rewards that will follow the desired behavior;
- (4) focus on the positive consequences that will result from the desired behavior as a way to motivate employees;
- (5) application of the scientific method to improve attempts at behavioral interventions;
- (6) use of theory to integrate information rather than to limit possibilities; and
- (7) planned interventions with the feelings and attitudes of the individual employee in mind.

DRUGS AND ACCIDENT CAUSATION

- One of the most pernicious causes of accidents on the job is chemicals—but not the kind industrial hygienists generally concern themselves with.
- The chemicals alluded to here are the illicit drugs and alcohol used by employees.
- Drugs and alcohol are the root cause or contributing cause of many accidents on the job every year.
- Consequently, safety professionals need to be on guard for employees who are drug and alcohol abusers.

DEPRESSION AND ACCIDENT CAUSATION

- An invisible problem in today's workplace is **clinical depression**. People who suffer from clinical depression are seriously impaired and, as a result, they pose a clear and present safety risk to themselves, fellow workers, and their employer.
- Mental health professionals estimate that up to 10 percent of the adult population in the United States suffers from clinical depression.
- This translates to 1 in every 20 people on the job.

Warning signs

- Persistent dreary moods (sadness, anxiety, nervousness)
- Signs of too little sleep
- Sleeping on the job or persistent drowsiness
- Sudden weight loss or gain
- General loss of interest, especially in areas of previous interest
- Restlessness, inability to concentrate, or irritability
- Chronic physical problems (headaches, digestive disorders, etc.)
- Forgetfulness or an inability to make simple decisions
- Persistent feelings of guilt
- Feelings of low self-worth
- Focus on death or talk of suicide

ACCIDENT INVESTIGATION

Dan Hartshorn defines an accident as “**any unplanned event that causes injury, illness, property damage or harmful disruption of work process.**”

- When an accident occurs, it is important that it be investigated thoroughly.
- The results of a comprehensive accident report can help safety and health professionals pinpoint the cause of the accident.
- This information can then be used to prevent future accidents, which is the primary purpose of accident investigation

- There are *accident reports* and there are *accident-analysis reports*
- An **accident report** is completed when the accident in question represents only a minor incident.
- It answers the following questions: *who*, *what*, *where*, and *when*
- An **accident-analysis report** is completed when the accident in question is serious.
- This level of report should answer the same questions as the regular accident report plus one more—*why*. Consequently, it involves a formal accident analysis.
- The analysis is undertaken for the purpose of determining the root cause of the accident.
- Accident analysis requires special skills and should be undertaken only by an individual with those skills

- There are two reasons:
- **First**, the accident analysis must identify the actual root cause or the company will expend resources treating only symptoms or, even worse, solving the wrong problem.
- **Second**, serious accidents are always accompanied by the potential for litigation. If there might be legal action as a result of an accident, it is important to have a professional conduct the investigation even if it means bringing in an outside consultant

Investigation, plan and method to acquire facts

- The first thing to do when an accident takes place is to implement **emergency procedures**.
- This involves bringing the situation under control and caring for the injured worker.
- As soon as all emergency procedures have been accomplished, the accident investigation should begin.
- Waiting too long to complete an investigation can harm the results- This is an important rule of thumb to remember.
- Another is that *all* accidents, no matter how small, should be investigated.
- **Evidence** suggests that the same factors that cause minor accidents may cause major accidents

- The purpose of an **accident investigation** is to collect facts. It is not to find fault. It is important that safety and health professionals make this distinction known to all involved.
- **Fault finding** can cause reticence among witnesses who have valuable information to share.
- **Causes** of the accident should be the primary focus. The investigation should be guided by the following words: **who, what, when, where, why, and how.**

- The National Safety Council (NSC) summarizes this approach:
- **As you investigate, don't put the emphasis on identifying who could be blamed for the accident.**
- **This approach can damage your credibility and generally reduce the amount and accuracy of information you receive from workers.**
- **This does not mean you ignore oversights or mistakes on the part of employees nor does it mean that personal responsibility should not be determined when appropriate.**
- **It means that the investigation should be concerned with only the facts. In order to do a quality job of investigating accidents you must be objective and analytical.**

In attempting to find the facts and identify causes, certain questions should be asked, regardless of the nature of the accident

- What type of work was the injured person doing?
- Exactly what was the injured person doing or trying to do at the time of the accident?
- Was the injured person proficient in the task being performed at the time of the accident?
- Had the worker received proper training?
- Was the injured person authorized to use the equipment or perform the process involved in the accident?
- Were there other workers present at the time of the accident? If so, who are they, and
- what were they doing?
- Was the task in question being performed according to properly approved procedures?
- Was the proper equipment being used, including personal protective equipment?
- Was the injured employee new to the job?

Cont'd...

- Was the process, equipment, or system involved new?
- Was the injured person being supervised at the time of the accident?
- Are there any established safety rules or procedures that were clearly not being followed?
- Where did the accident take place?
- What was the condition of the accident site at the time of the accident?
- Has a similar accident occurred before? If so, were corrective measures recommended?
- Were they implemented?
- Are there obvious solutions that would have prevented the accident

Common Causes of Accidents

Hartshorn places many of the common causes of accidents in the following categories:

- **personal beliefs and feelings**
- **decision to work unsafely**
- **mismatch or overload**
- **systems**
- **Failures**
- **Traps**
- **unsafe conditions**
- **unsafe acts**

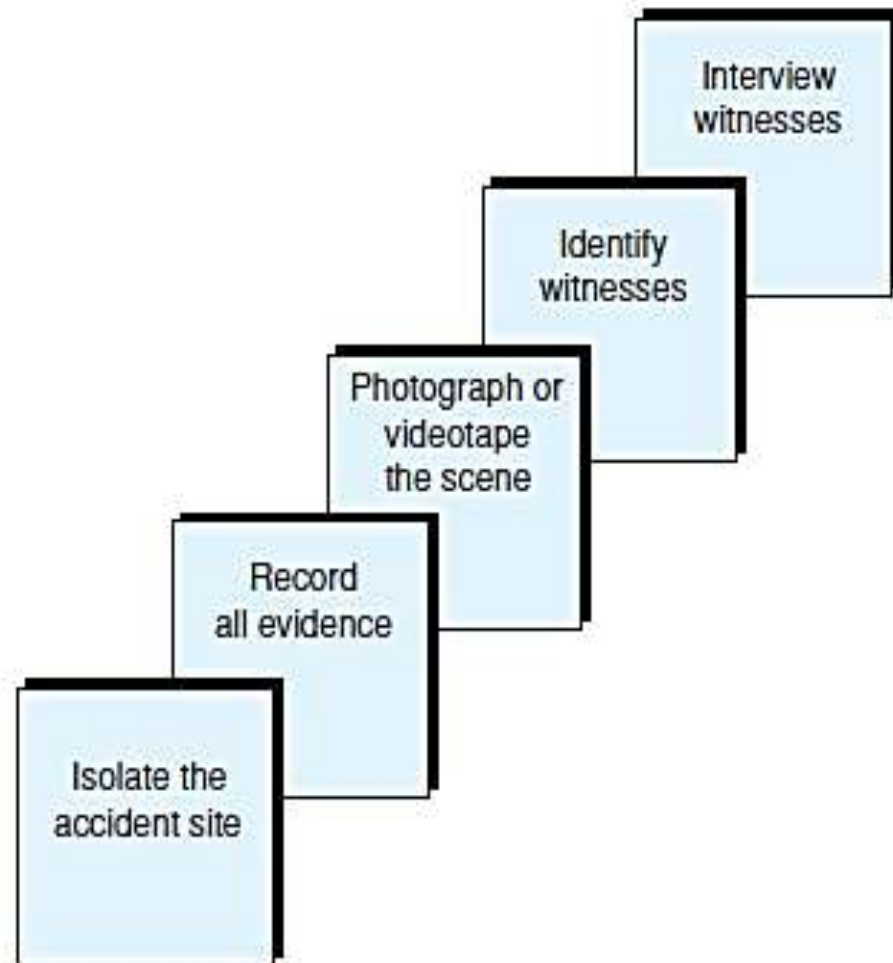
WHO SHOULD INVESTIGATE

- Size of the company
- Structure of the company's safety and health program
- Type of accident
- Seriousness of the accident
- Technical complexity
- Number of times that similar accidents have occurred
- Company's management philosophy
- Company's commitment to safety and health

CONDUCTING THE INVESTIGATION

Figure 8–1

Steps in conducting an accident investigation.



Isolate the Accident Scene

- The entire area surrounding such a scene is typically blocked off by barriers or heavy yellow tape.
- This is done to keep curious onlookers from removing, disturbing, or unknowingly destroying vital evidence.
- The same approach should be used when conducting an accident investigation.
- As soon as emergency procedures have been completed and the injured worker has been removed, the accident scene should be *isolated* until all pertinent evidence has been collected or observed and recorded. Further, nothing but the injured worker should be removed from the scene.
- If necessary, a security guard should be posted to maintain the integrity of the **accident scene**.
- The purpose of isolating the scene is to maintain as closely as possible the conditions that existed at the time of the accident.

Record All Evidence

- It is important to make a permanent record of all *pertinent evidence* as quickly as possible.

There are three reasons for this:

- (1) certain types of evidence may be perishable;
 - (2) the longer an accident scene must be isolated, the more likely it is that evidence will be disturbed, knowingly or unknowingly; and
 - (3) if the isolated scene contains a critical piece of equipment or a critical component in a larger process, pressure will quickly mount to get it back in operation.
- Evidence can be recorded in a variety of ways, including written notes, sketches, photography, videotape, dictated observations, and diagrams.

Photograph or Videotape the Scene

- This step is actually an extension of the previous step.
- Modern photographic and videotaping technology has simplified the task of observing and recording evidence.
- Safety and health professionals should be proficient in the operation of a camera, even if it is just an instant camera, and a videotaping camera.

Identify Witnesses

- In **identifying witnesses**, it is important to compile a witness list.
- Names on the list should be recorded in three categories:
 - (1) **primary witnesses**,
 - (2) **secondary witnesses**, and
 - (3) **tertiary witnesses**

Interview Witnesses

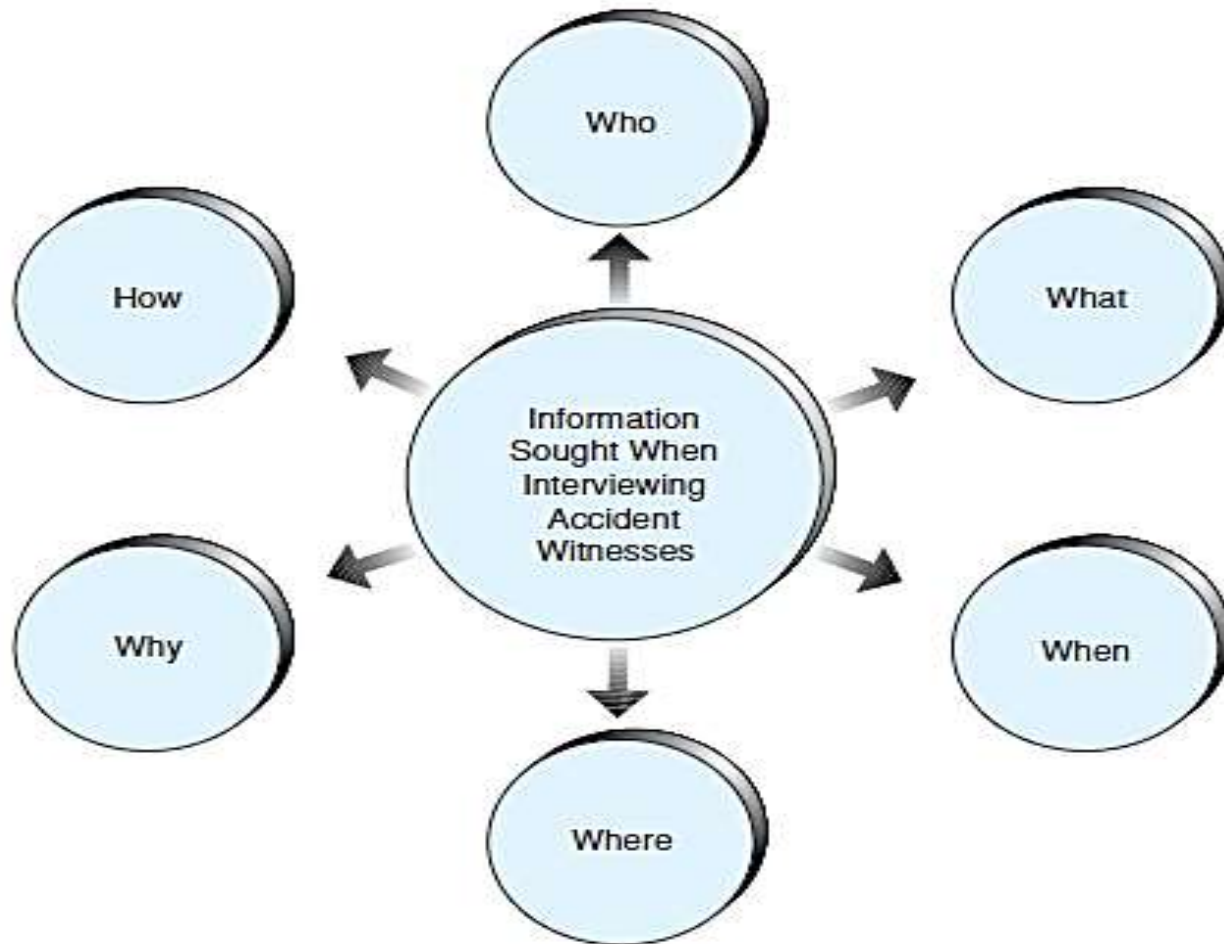


Figure 8-3

Questions to ask when interviewing witnesses.

Supervisor- Accident Investigation

- Supervisors play a key role in the maintenance of a safe and healthy workplace.
- A *Safety & Health* survey revealed that only 53 percent of the companies responding provide safety and health training for their supervisors.
- In the words of Peter Minetos, “Supervisors . . . are the ones who have to teach employees the safe way to conduct their jobs. With proper training, they can spot and eliminate risks that are waiting to create havoc for their workers

Session 1

Loss Control for Supervisors

Accidents and incidents, areas of responsibility, the cost of accidents, and a better approach to occupational safety and health.

Session 2

Communications

Elements of communication, methods of communication, and effective listening.

Session 3

Human Relations

Human relations concepts, leadership, workers with special problems, and the drug and alcohol problem.

Session 4

Employee Involvement in Safety

Promoting safe-worker attitudes, employee recognition, safety meetings, and off-the-job accident problems.

Session 5

Safety Training

New employee indoctrinations, job safety analysis (JSA), job instruction training (JIT), and other methods of instruction.

Session 6

Industrial Hygiene and Noise Control

General concepts, chemical agents, physical agents, temperature extremes, atmospheric pressures, ergonomics, biological stresses, threshold limit values (TLVs), and controls.

Session 7

Accident Investigation

Finding causes, emergency procedures, effective use of witnesses, and reports.

Session 8

Safety Inspections

Formal inspections, inspection planning and checklists, inspecting work practices, frequency of inspections, recording hazards, and follow-up actions.

Session 9

Personal Protective Equipment

Controlling hazards, overcoming objections; protecting the head, eyes, and ears; respiratory protective equipment; safety belts and harnesses; protecting against radiation; safe work clothing; and protecting the hands, arms, feet, and legs.

Session 10

Materials Handling and Storage

Materials handling problems; materials handling equipment; ropes, chains, and slings; and material storage.

Thank you