

INTRODUCTION TO



MDM SITI FARHANA BINTI ZAINAL BAKRI
LECTURER
FACULTY OF ENGINEERING & TECHNOLOGY

CHAPTER 4:

4.2 THEORY OF ACCIDENT CAUSATION & INVESTIGATION

Learning Outcomes

After completing this chapter, student 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


SINGLE FACTORS THEORY OF ACCIDENT CAUSATION



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. ***Pre-contact phase:*** refers to those events or conditions that lead up to the accident.  **UNSAFE ACT / UNSAFE CONDITION**

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.  **INCIDENT / ACCIDENT**

3. ***Post-contact 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 post-contact phase of the domino theory.

 **INJURY / DEATH / DAMAGE / HARM EFFECT**

Domino Theories

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 pre-contact 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:*

- i. Negative character traits **leading a person to behave** in an unsafe manner can be inherited or acquired as a result of the social environment.
- ii. Negative character traits are **why individuals behave** in an unsafe manner and why hazardous conditions exist.
- iii. Unsafe acts committed by individuals and mechanical or physical hazards are the direct causes of accidents.
- iv. **Falls and the impact** of moving objects typically cause accidents resulting in injury.
- v. Typical injuries **resulting from accidents** include lacerations and fractures.

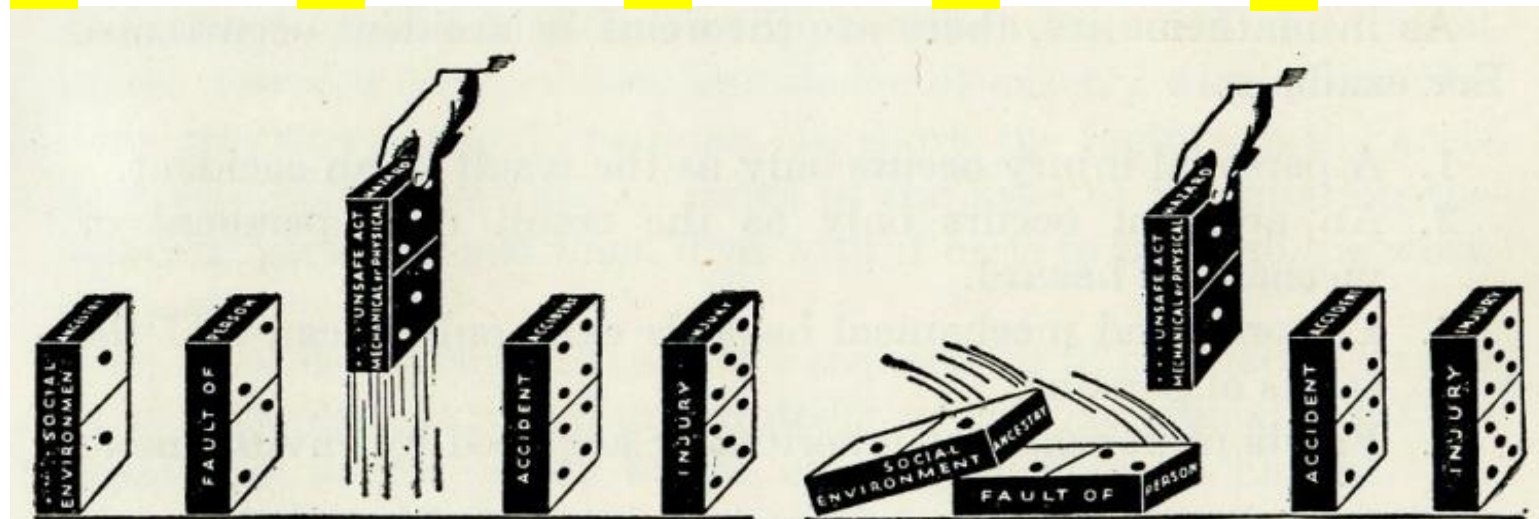
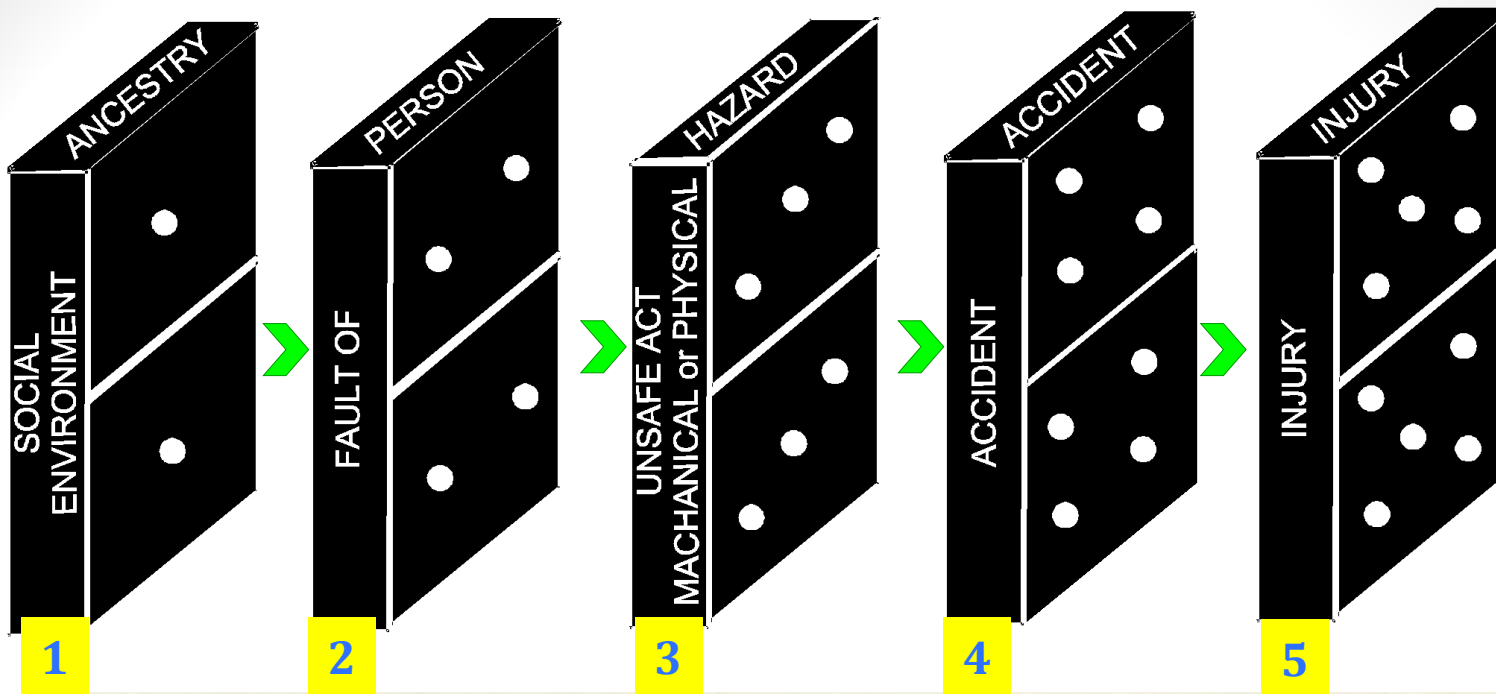
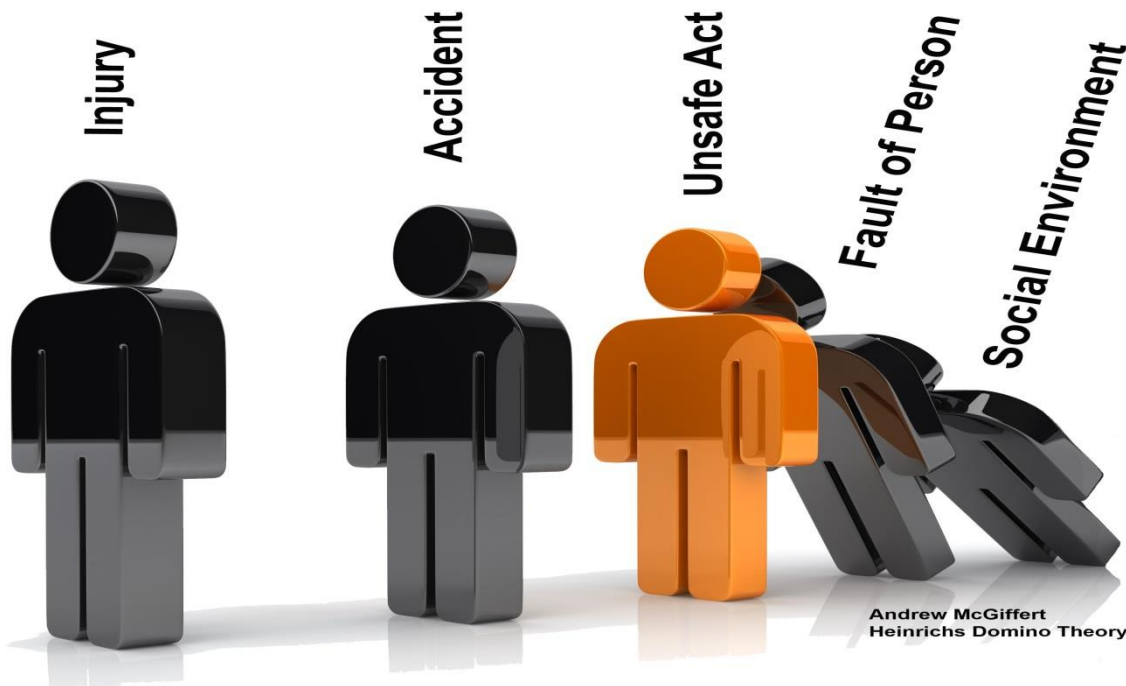


FIG. 4. The unsafe act and mechanical hazard constitute the central factor in the accident sequence.

FIG. 5. The removal of the central factor makes the action of preceding factors ineffective.

Heinrich's Domino Theory

- 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).

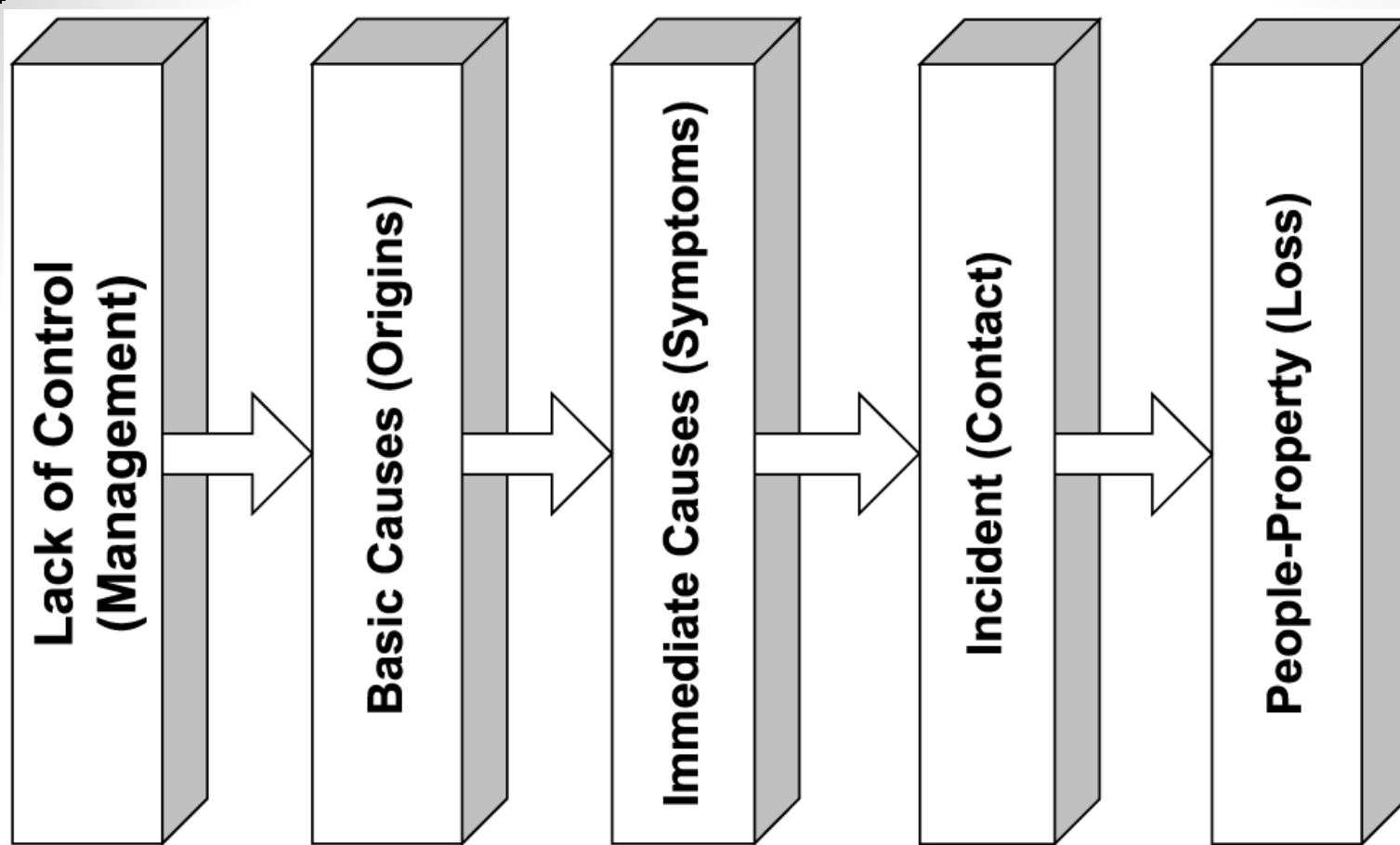


Bird and Loftus' Domino Theory

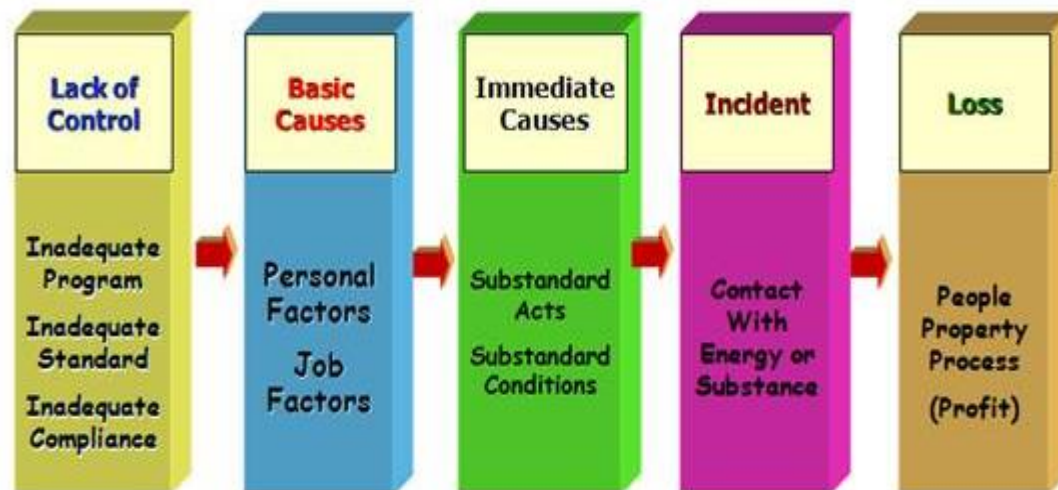
Bird and Loftus (1976) updated the domino sequence to reflect the management's relationship with the causes and effects of all incidents. ***Bird and Loftus' theory uses five dominos that represent the following events involved in all incidents:***

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:**
 - i. **Personal factors** such as lack of knowledge or skill, improper motivation, and/or physical or mental problems, and
 - ii. **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 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 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.



Source: Bird and Loftus (1976)



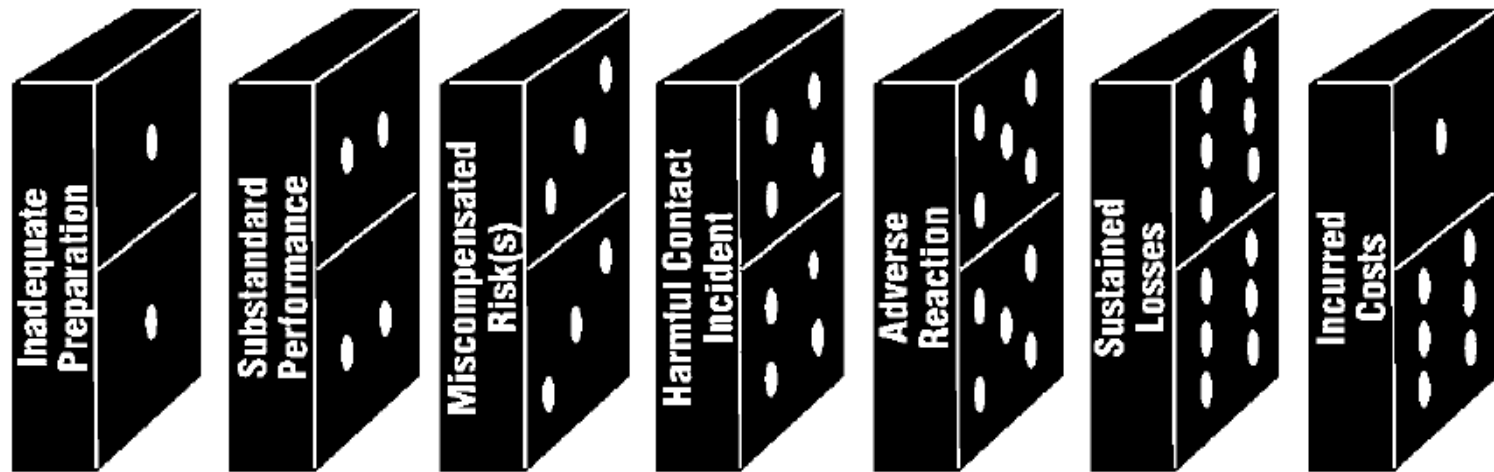
Marcum's Domino Theory

- 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.**
- 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.
- 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.

Marcum's Domino Theory

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



MULTIPLE FACTORS THEORY OF ACCIDENT CAUSATION



A. 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.
- Grose's multiple factors theory uses four **M**s to represent factors causing an accident: *Machine, Media, Man, and Management* (Brauer, 1990).

4 Ms:



1. Machine:

- Refers to **tools, equipment, or vehicles** contributing to the cause of an accident.
- Examination of machinery characteristics includes the design, shape, size, or specific type of energy used to operate the equipment.



2. Media:

- Includes the environmental conditions surrounding an accident, such as the weather conditions or walking surfaces.
- Snow or water on a roadway, temperature of a building, and outdoor temperature can be characteristics of media.

4 Ms:



3. Man:

- deals with the people and human factors contributing to the incident.
- 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).

4. Management:

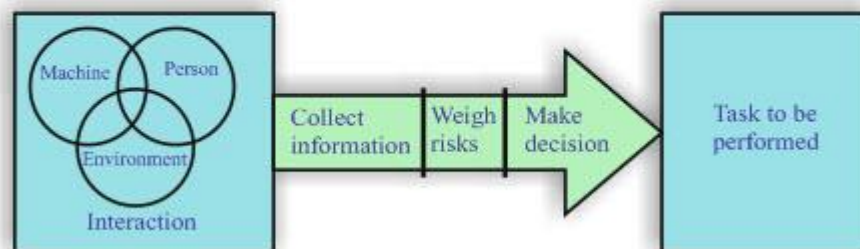
- also incorporates the other three Ms, looking at the methods used to select equipment, train personnel, or ensure a relatively hazard-free environment.
- Characteristics of management could include safety rules, organizational structure, or policy and procedures.

- 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.

B. 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.

System Theory Model



Examples of Systems Theory.....

- 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-foothigh 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



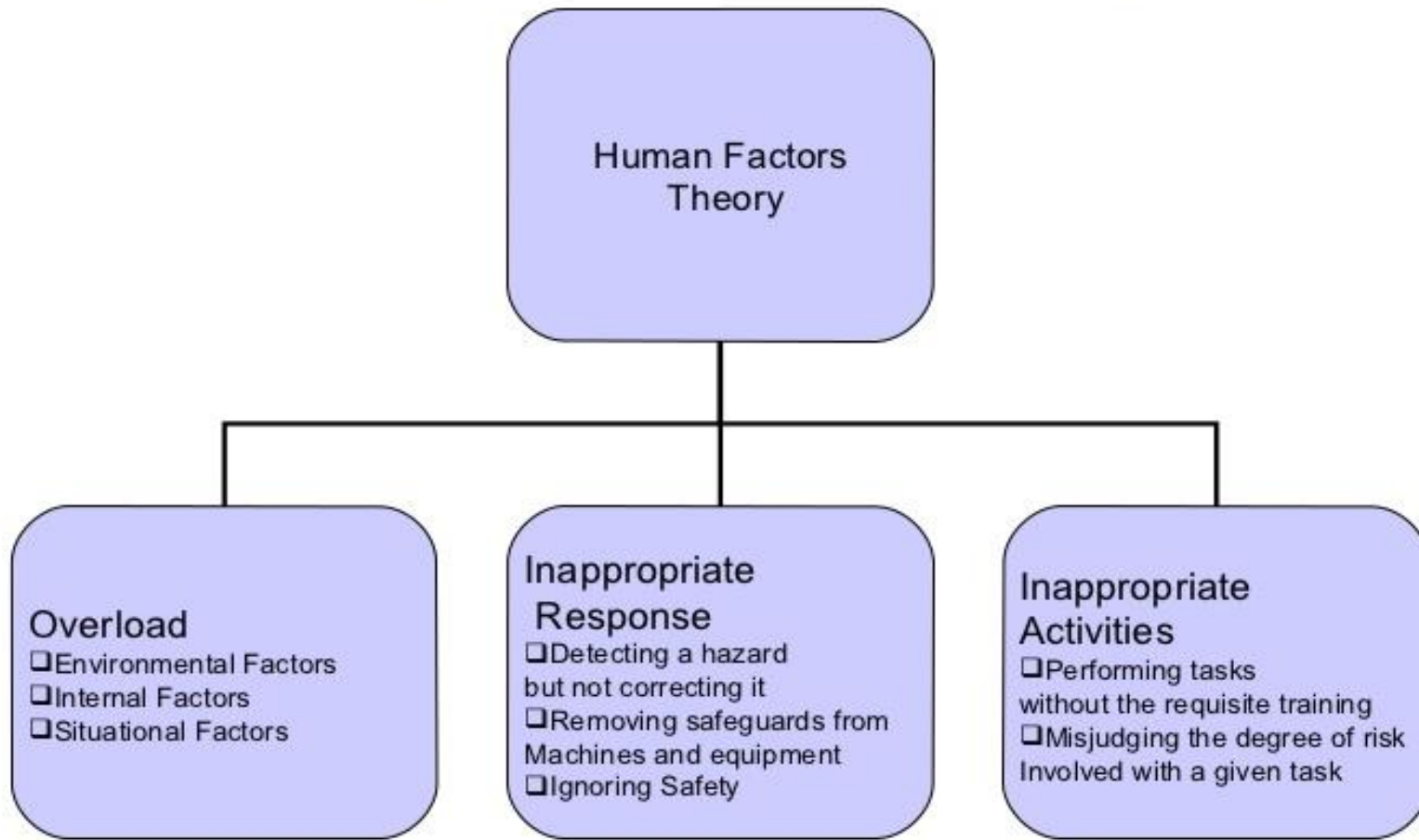
Human Factors Theory

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

- **Overload**: 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**: Is another term for human error. When individuals undertake a task without proper training, they are acting inappropriately.
- **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.

HUMAN FACTORS THEORY



ACCIDENT INVESTIGATION



- 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.**

A systematically studied where a root causes and contributing factors can be identified



- ❖ Who are the victims?
- ❖ Who are the witnesses?
- ❖ What events led up to the accident?
- ❖ What were victims and witnesses doing prior to and during the incident?
- ❖ When did the incident occur?
- ❖ When did you become concerned that a problem existed?
- ❖ Where were equipment and/or machinery?
- ❖ Where were the PPE or the locks and tags for energy sources?
- ❖ Why were particular methods used to perform a task?
- ❖ Why were these conditions existing at the time of the incident?
- ❖ How did the incident take place?
- ❖ How did the victims and witnesses react in given situations?

To **prevent repetition** of the same work- related injuries, ill health, diseases and incidents

Legal Requirement



WHY Investigate An Incident??

Accurate **record** (for insurance, legal prosecution, public enquiries)

Organisation's own **policy and business reasons**



WHO Should Investigate??



► Depends On Severity Of The Incident

• Internal Investigation team

- Individuals involved
- Supervisor, Safety officer
- Upper management
- external consultants
- Members of the Safety and Health Committee

► External agency involvement

- DOSH and / or DOE, Police, etc.

WHAT & WHEN To Investigate??

• **All** serious and long-term incidents & near misses

• **As soon as possible** to prevent:

- Scene interference
- Deterioration of evidence
- Losing people's recollection of the incidence





Principles Of Incident/Accident Investigation

Principles Of Investigation

- Carried out according to procedure:
 - For all incidents
 - By **competent persons** with participation of workers.

▶ Should:

- ▶ Be **systematic and documented**
- ▶ **Be objective** (fact finding only)
- ▶ Be **treated as urgent** (to prevent productivity loss and deterioration of evidence)
- ▶ Find the **underlying root cause**
- ▶ **Identify failures in OSH management system**
- ▶ Implement **corrective action**



Principles Of Investigation (Cont...)

- The **results** should:
 - Be **communicated** to the **Safety and Health Committee** who should make appropriate recommendations
 - Include external investigation reports such as DOSH and SOCSO
 - Be communicated to appropriate persons for **corrective action**
 - **Included in management review**

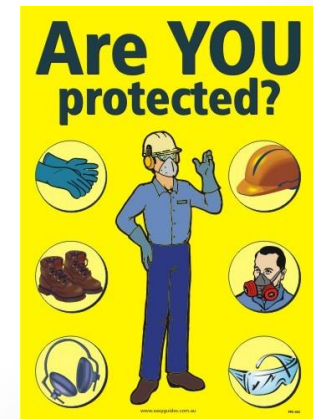
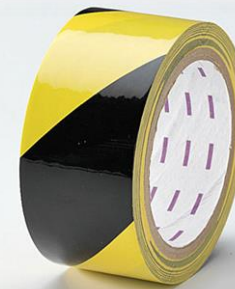
Investigation Kit Preparation



- Camera & Video Camera
- Flash and Batteries
- Cassette Tape Recorder
- Mobile Telephone / Walkie-Talkie



- Clipboard, Pre-printed Forms
- PPE
- Containers for Taking and Storing Samples
- Barrier Tape



Responsibilities

Employee

- Record in incident book (supervisor checks)

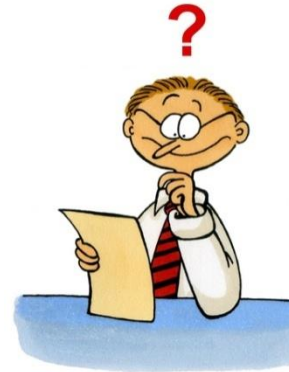


Supervisor / Manager

- Initiate risk control response: first-aid, fence area, etc. other preventive action
- Inform SHO

SHO

- ▶ Organise camera, tape and report form
- ▶ Check line management report
- ▶ Investigate if incident is serious and require to **notify authorities** such as DOSH, DOE, Police, etc.
- ▶ Complete incident record form
- ▶ Summary report to Safety and Health Committee





Preventive And Corrective Action

Corrective & Preventive Action

- Preventive and corrective action should be carried out for:
 - **Incidents**
 - **Management system non-conformances**
- Recommendation for preventive and corrective actions must be communicated clearly



Implementing Corrective & Preventive Action

- Must be **based on root causes**
- Reviewed through **risk assessment process** to ensure that the correction will not introduce a new hazard
- Strict time table for implementation established
- **Follow up** conducted



Question.

1. What are the two factors associated with risk? Explain how these two factors impact on the selection of accident controls.
2. Is it important to conduct accident investigations? Why?
3. What are the advantages of considering accidents as management problems?



GROUP ASSIGNMENTS

1. Choose your topic of interest:
 - a) Epidemiological Theory.
 - b) Swiss cheese Theory.
 - c) Drugs, Depression and Accident Causation.
2. Present on **24/11/2014 (11.30 am – 1.30 pm)** by using PowerPoint.
3. 10 minutes of presentation + 5 minutes of Q&A Session.
4. Submit the hardcopy before your presentation.

thank
thank
you!