Lecture 2: Accident Prevention, PPE

Course: Health Safety & Environment

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BUITEMS – DEPARTMENT OF MECHANICAL ENGINEERING

Sources of Hazards

- The work environment
- Equipment/plant/process
- Substances/materials
- Work system
- People

5 M

Man

Machine

Method

Material

Milieu

Broad Categories of Hazards

Category	Example
Safety Hazards	
Chemical Hazards	acidity, alkalinity, corrosivity, explosiveness, flammability, toxicity, asphyxation.
Mechanical Hazards	moving equipment, tripping hazards, impact and forces
Thermodynamics Hazards	high/low temperature, high pressure, vacuum, heat transfer
Electrical & Electromagnetic Hazards	high voltage, radiation, static electricity, electrical current
Health Hazards	noise, pollution, vibration, radioactivity,
External Threats	accidental damage by missiles and vehicles, act of god and natural causes

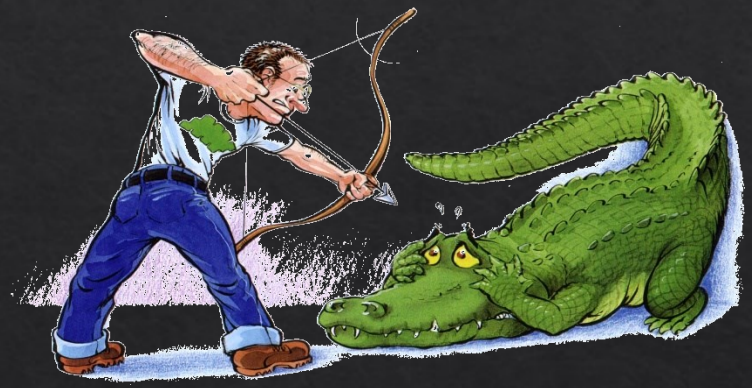
Hazard Identification and Risk Assessment

1. Identify the hazard

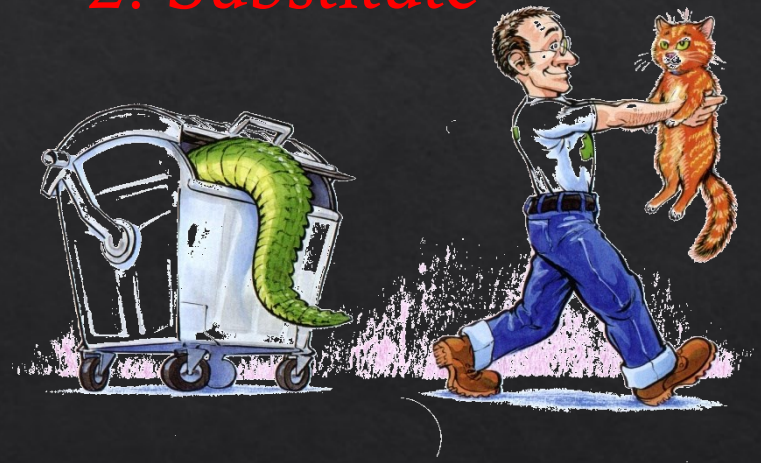
2. Estimating the risk associated with the hazard

Hazard Control Hierarchy

1. Eliminate



2. Substitute

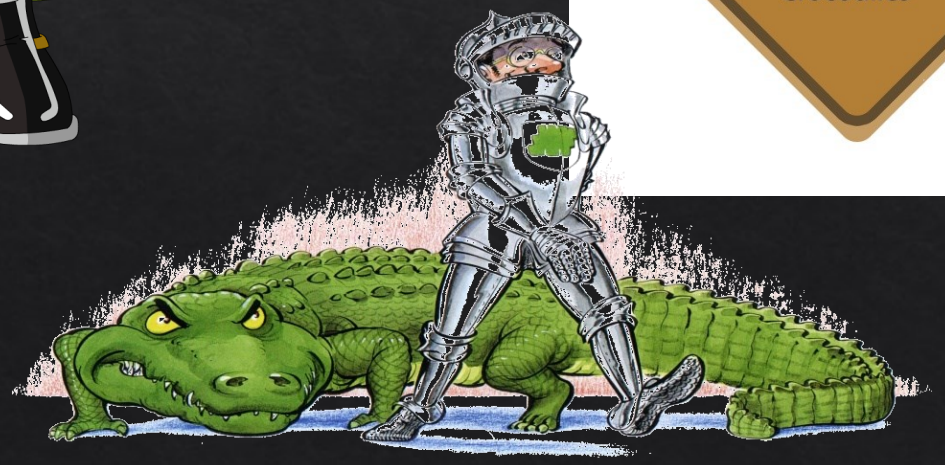


3. Isolate

Hazard Control Hierarchy

4. Engineering Control

5. Administrative Control



6. Use PPE

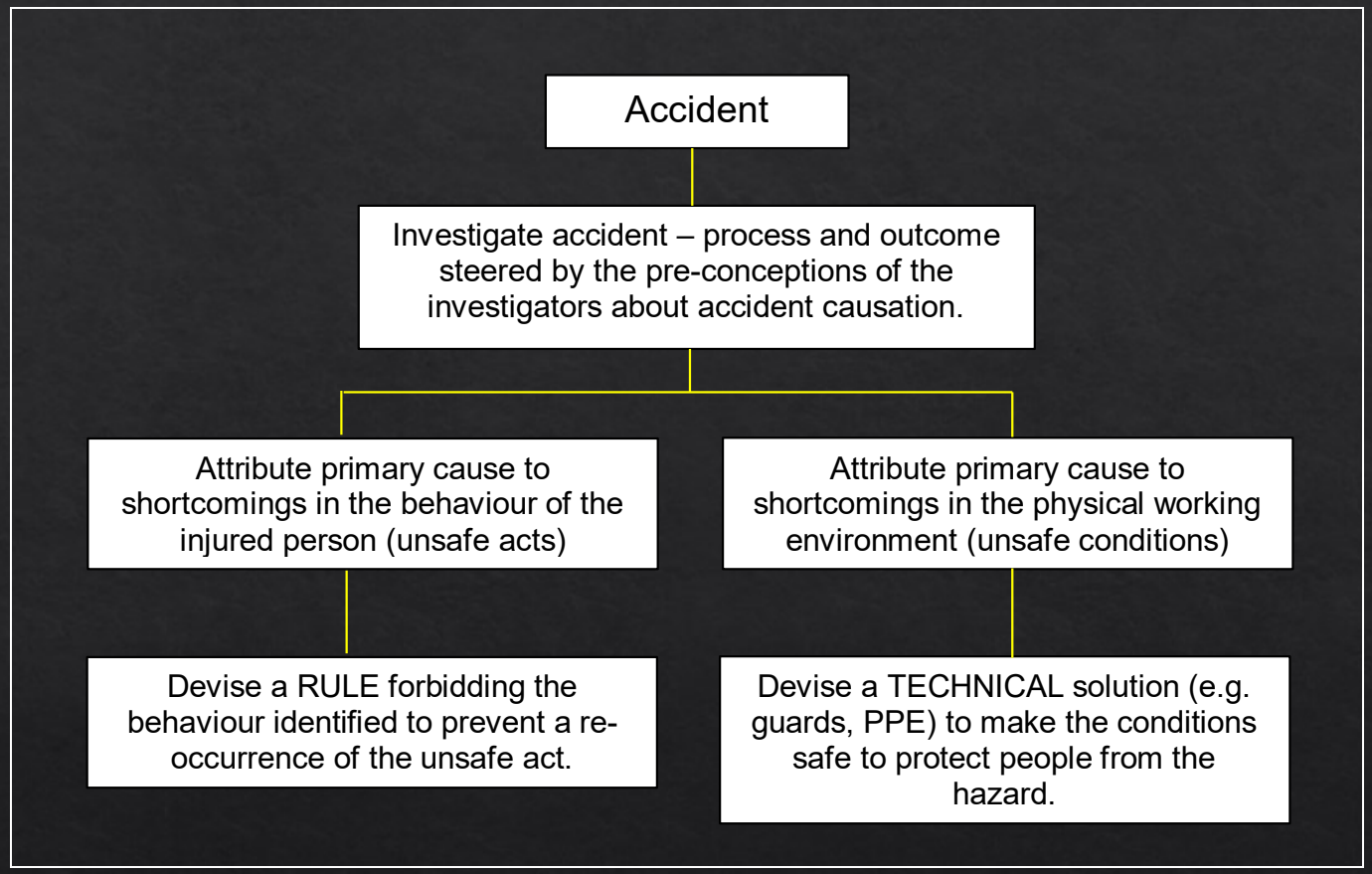
Hazard Control Hierarchy

No.	Control Method	Description/Example
1.	Eliminate	Completely remove the hazard from the workplace so that it is not there.
2.	Substitute	Replace the material or process with a less hazardous one.
3.	Isolate	Place a barrier or similar between the hazard and people within the workplace (e.g. a fence surrounding the hazard).
4.	Engineering controls	Install or using additional machinery. (e.g ventilation system, guarding on machinery, sensor system).
5.	Administrative controls	Safety briefings, safety trainings, work procedure, safety awareness signage.
6.	PPE	"Last line of defence" to protect a worker if the above measures have failed.

Accident Prevention

- Requires the creation and maintenance of a safe working environment, and the promotion of safe behaviour.
- Originally a reactive process - waiting for accidents or ill health to happen and then devising and implementing a prevention control.

Accident Prevention



Unsafe Acts & Conditions in Quarries

Unsafe Acts

- Operating equipment at improper speeds
- Operating equipment with authority
- Using equipment improperly
- Using defective equipment
- Failure to wear PPE
- Taking and improper working position
- Servicing equipment in motion
- Defeating safety devices

Unsafe Conditions

- Inadequate guards
- Defective tools or equipment
- Congestion of working area
- Poor housekeeping
- Excessive noise
- Poor illumination
- Poor ventilation

Operating Procedures

- Most common form of control measure
- In some cases the only practical way of managing a particular risk.
- Should allow for methodical execution of tasks.
- Should address the hazards that have been identified in the risk assessment.
- Requirement of law - Section 10 of the Quarry Regulations, 1999, it is *'the duty of the quarry operator to ensure that rules and procedures are in place for reasons of health and safety'.*

A Safe System of Work

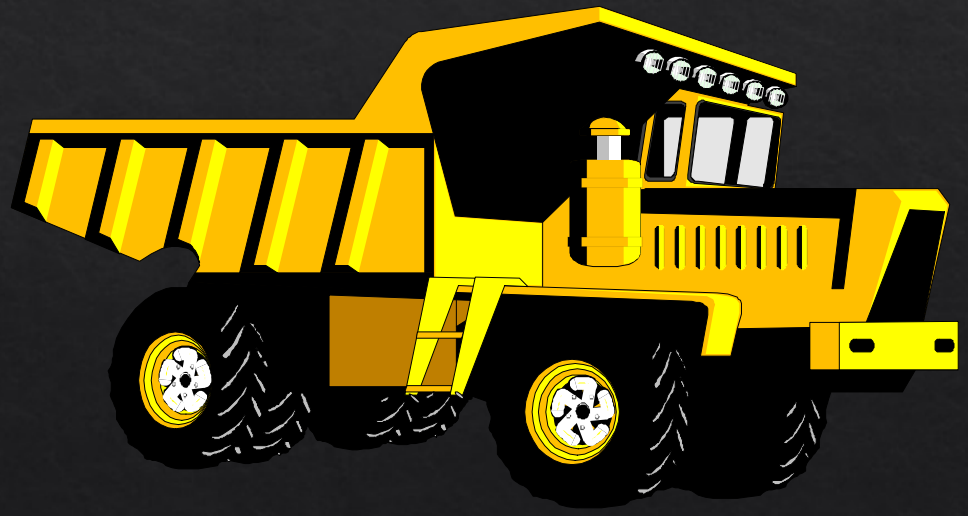
- Eliminates identified hazards and controls others.
- Plans to achieve the controlled completion of the work with minimum risk.
- Fundamental to accident prevention.
- Should fully document the hazards, precautions and safe working methods.

Framework for Safe System of Work

1. Safe design.
2. Safe installation.
3. Safe premises and plant.
4. Safe tools and equipment.
5. Correct use of plant, tools and equipment.
6. Effective planned maintenance of plant and equipment.
7. Proper working environment ensuring adequate lighting, heating and ventilation.
8. Trained and competent employees.
9. Adequate and competent supervision.
10. Enforcement of safety policy and rules.
11. Additional protection for vulnerable employees.
12. Formalised issue and proper utilisation of all necessary clothing.
13. Continued emphasis on adherence to the agreed safe method of work.
14. Regular annual reviews of all systems of work to ensure:-
    - Compliance with current legislation.
    - Systems are still workable in practice.
    - Plant modifications are accounted for.
    - Substituted materials are allowed for.
    - New work methods are incorporated into the system.
    - Advances in technology are exploited.
    - Proper precautions in light of any accidents are taken.
    - Continued involvement in and awareness of the importance of written safe systems of work.
15. Regular feedback to all concerned.

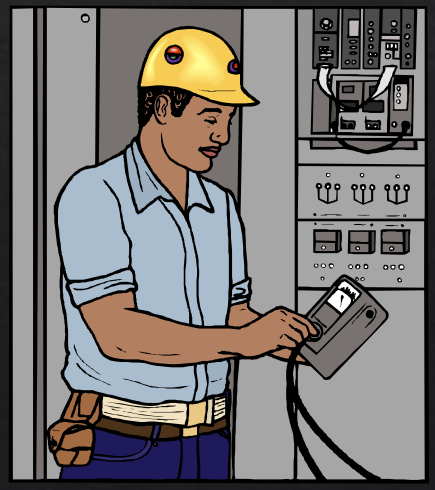
Maintenance

Concerned with the reliability of machines or equipment.



Permits to Work (PTW)

- Formal ‘safe system of work’
- Not generally used for low risk operations.
- Permit to Work Systems are required by Regulation 18 of the Quarry Regulations, 1999.



Permit to Work

The essential elements of a PTW scheme are:

- Full explanation of the hazards involved to the workforce.
- The work to be carried out is properly detailed and understood by both sides.
- The area in which the work to be carried out is properly detailed and understood by both sides.
- The area is which the work is to be carried out is clearly identified and made safe, or the hazards are highlighted.
- The workmen must sign the permit to say that they fully understand the work that is to be carried out, and the hazards and potential risks to be faced.
- When the work is finished, the workmen must sign off the permit to say that they have completed the specified work and left the operation in a suitable state.

Training

Training helps people acquire the skills, knowledge and attitudes to make them competent in the health and safety aspects of their work.

There are generally two types of safety training:-

- Specific safety training (or on the job training) for tasks of a specific nature.
- Planned training, such as general safety training, induction training, management training, skill training or refresher courses, that are planned by the organisation.

Personnel Protective Equipment

Personnel protective equipment (PPE) may be broadly divided as follows:

- Hearing protection.
- Respiratory protection.
- Eye and face protection.
- Protective clothing.

PPE does nothing to stop the hazard at source, but simply provides protection to reduce the severity of the potential accident.

Personnel Protective Equipment

It is only an effective control if worn and so any organisation which provides for the issue of PPE should:

- Carry adequate stock.
- Enable accessibility at appropriate times.
- Respond to changing demands.
- Have a system for exchanging equipment.
- Be managed to ensure its effective running.

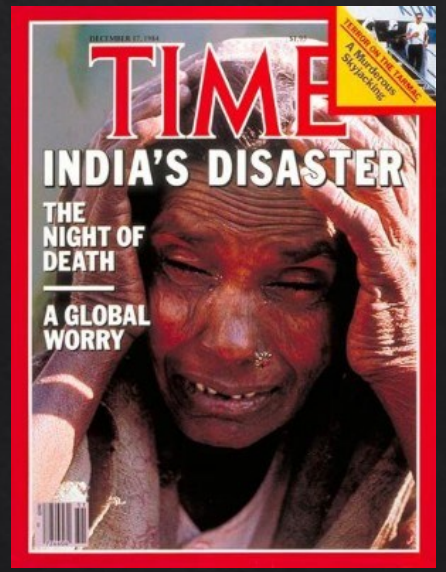
PROTECTIVE EQUIPMENT REQUIREMENTS			
WHERE NEEDED	**Eye** Where machines or operations present a danger from flung objects,, hazardous liquids, or injurious radiation.	**Head** Where there is danger from impact and penetration from falling or flying objects or from limited electric shock.	**Foot/Toe** In areas where there is a potential for foot or toe injuries.
TYPES OF PROTECTION	Goggles, full face shields, safety glasses, side-shields, welders' lenses (should meet standards).	Safety hats full brim, brimless, limited voltage protection, no voltage protection, (should meet standards).	Impact and compression resistance, metatarsal protection, puncture resistance, electrical hazard resistance, conductive
FITTING REQUIREMENT	Comfortable fit (not interfere with movement).	Comfortable, proper fit.	Proper fit.
SUGGESTED RECORDS	Date issued, reissued, type issued, instructions given	Date issued, type issued, instructions given (need to wear, maintenance, disciplinary action).	Date issued, amount reimbursed, instructions given (need to wear, maintenance, disciplinary action).
EXAMINATIONS NEEDED	Visual acuity, depth perception.		

PROTECTIVE EQUIPMENT REQUIREMENTS (2)			
WHERE NEEDED	**Hand** Danger of cuts, or from handling corrosives, solvents, or other chemicals.	**Hearing** Noise exposure that equals or exceeds 85 dBA in an 8-hour time-weighted period.	**Respiratory** In areas that present a limited breathable environment
TYPES OF PROTECTION	Cotton/leather gloves; gauntlets; heat-resistant gloves; barrier creams; chain mail gloves; haly-gloves; rubber gloves. (Should meet standards).	Full muffs, disposable plugs, Swedish wool, non-disposable plugs. (Should meet standards).	Air-purifying respirators, chemical cartridge respirators, air-supplied respirators, combination respirators, self contained breathing devices. (Should meet standards).
FITTING REQUIREMENTS	Proper fit.	Proper fit, correct type for noise exposure.	Significant fitting requirements.
SUGGESTED RECORDS	Date issued, reissued, type issued, instructions given, (need to wear, maintenance, conservation, disciplinary action.)	Audiometric exam, date issued, instructions given (need to wear, effects of noise, cleaning, conservation, fitting, disciplinary action.)	Date issued, reissued, type issued, instructions given (respiratory hazards present; functions; fit testing; proper utilisation, cleaning and maintenance; conservation, disciplinary action).
EXAMINATIONS NEEDED		Audiometric (baseline and annual).	Pulmonary function.

Some Major Industrial Accidents in the Past

Bhopal, 1984

- Release of toxic gas
  - 40 tons of Methyl Isocynate (MIC) escaped from Union Carbide Plant in Bhopal, India.
  - 3000 died (respiratory failure)
  - Thousands more died in weeks that followed
  - More than 500,000 suffered

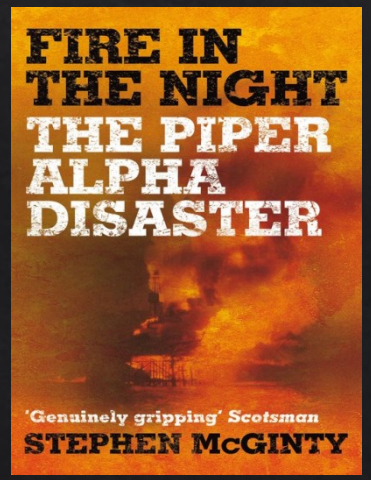


Chernobyl, 1986

- 26 April 1986 at the Chernobyl Nuclear Reactor, Ukraine.
- Large area of Russia, Ukraine and Belarus was evacuated, 336 000 people resettled.
- Fewer than 50 direct death, but thousands of cancer-related cases.
- Severe damage to the environment.

Piper Alpha, 1988

- World's most famous oil rig disaster.
- 167 out of 229 people died
- Initial explosion followed by a fierce fire which, in turn, triggered off a further series of explosions.
- Flames could be seen 100 km away.



Deep Water Horizon Platform, 2006

- Gulf Coast of United States
- Platform explosion and sinking, killed 11 workers
- Leaking of hundreds of thousands of barrels of oil into the Gulf of Mexico
- The worst industrial environmental disaster in US history.

Engineering Ethics: Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties.

Theories of Accident Causation

Why do accidents occur?

- We choose to handle dangerous processes, materials, energies
  - To make a living
  - To provide society with desirable products
- As long as we choose to handle them, a potential for loss events exist.

Things can be done to reduce their likelihood and severity to negligible or tolerable levels.

How do accidents occur?

- There are several theories that attempt to explain the occurrence of accidents.
  - Domino theory
  - Human factors theory
  - Swiss cheese model
  - Accident/incident theory
  - Sociotechnical system framework
  - Epidemiological Theory

Domino Theory

- Herbert W. Heinrich, an early pioneer of accident prevention and industrial safety.
- He studied 75,000 reports of accidents for insurance claims and concluded:
  - ***88%*** *of industrial accidents are caused by unsafe acts committed by workers*
  - ***10%*** *of industrial accidents are caused by unsafe conditions*
  - ***2%*** *of industrial accidents are unavoidable.*

Heinrich's Axiom of Industrial Safety

1. Injuries result from a complete series of factors, one of which is the accident itself
2. An accident can occur as a result of unsafe act and/or unsafe conditions
3. Most accidents are the result of unsafe behaviour by people
4. An unsafe act or an unsafe conditions does not immediately result in an accident/injury;

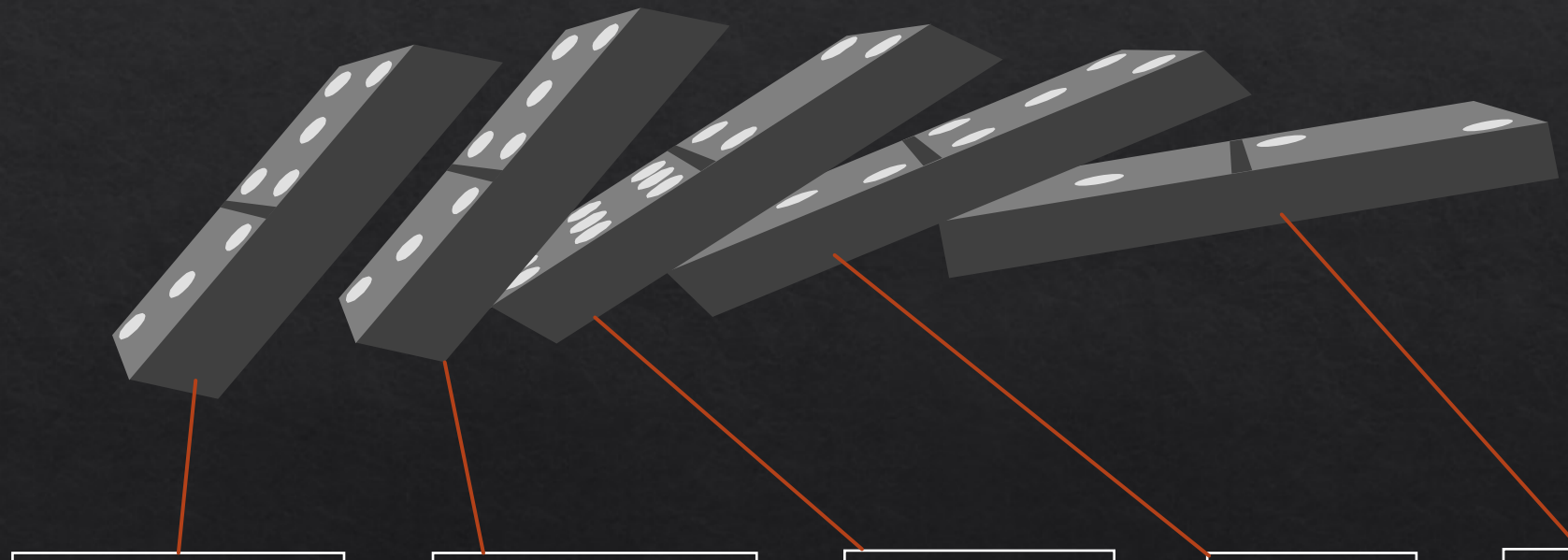
Heinrich's Axiom of Industrial Safety

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 factors that cause it are largely preventable.
7. The prevention techniques are analogous with the best quality and productivity techniques.

Heinrich's Axiom of Industrial Safety

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 (i.e. compensation, liability claims, medical costs, and hospital expenses) there are also hidden or indirect costs.

5 factors in the sequence of events leading up to an accident



Social Environment and Ancestry → Fault of Person (Carelessness) → Unsafe Act or Condition → Accident → Injury

5 factors in the sequence of events leading up to an accident

- Ancestry and social environment
  - Negative character traits that might lead people to behave in an unsafe manner can be inherited or acquired as a result of the social environment.
- Fault of a person
  - Negative character traits, whether inherited or acquired, are why people behave in unsafe manner and why hazardous conditions exist.

5 factors in the sequence of events leading up to an accident

- Unsafe act/Unsafe conditions
  - Unsafe acts committed by people
  - Unsafe conditions due to the presence of mechanical/physical hazards
- Accidents
- Injury

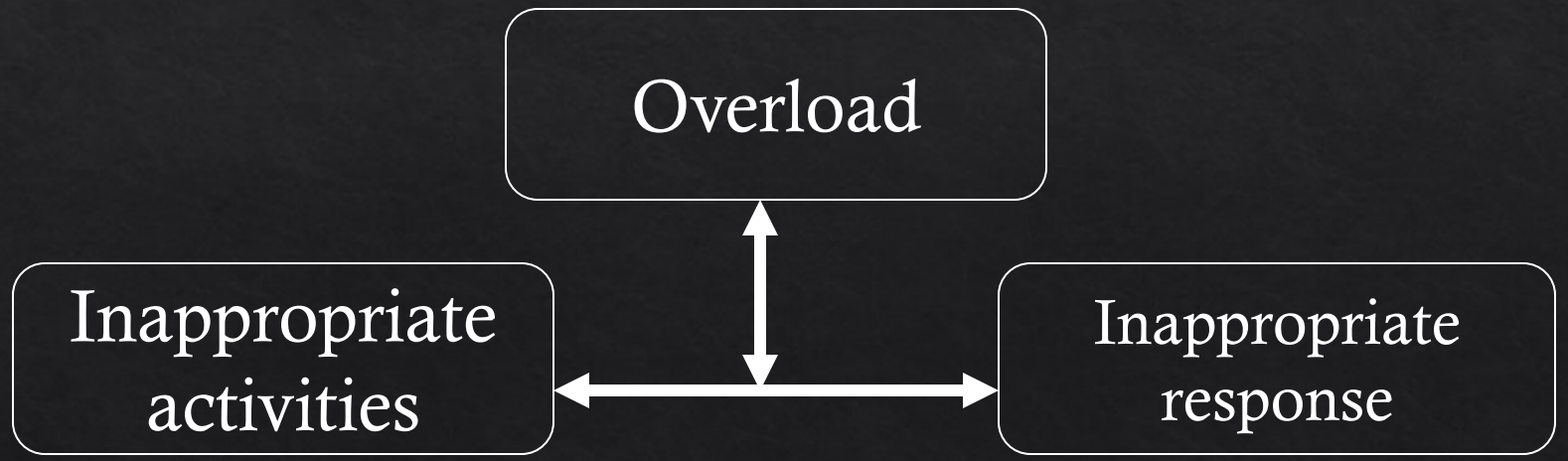
Heinrich's theory has two central points:

1. Injuries are caused by the action of preceding factors

2. Removal of the central factor (unsafe acts/hazardous conditions) negates the action of the preceding factors and, in so doing, prevents accidents and injuries.

Human Factors Theory

Attributes accidents to a chain of events that were ultimately the result of human error.



Overload

- An imbalance between a person's capacity at any given time and the load that a person is carrying in a given state.

- A person's capacity is the product of such factors as his/her ability, training, state of mind, fatigue, stress, and physical conditions.

Overload

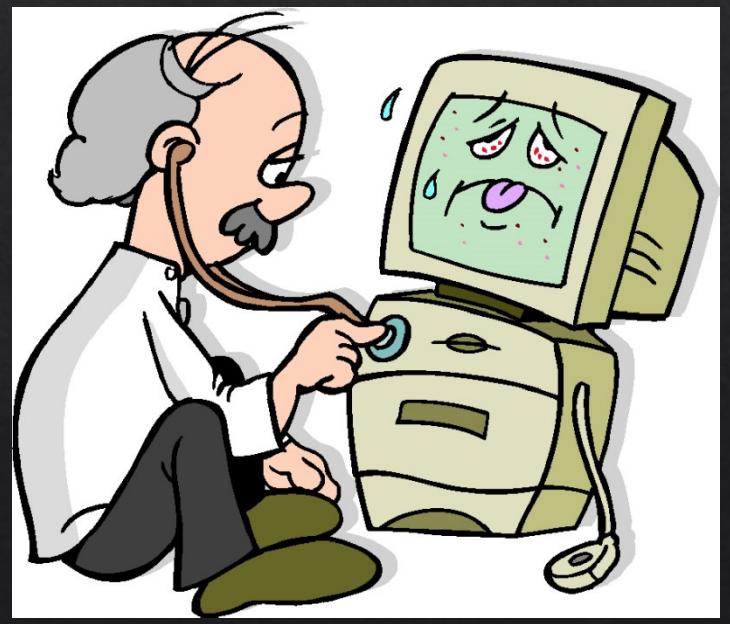
- Added burden resulting from
  - Environmental factors (noise, distractions, etc.);
  - Situational factors (level of risks, unclear instructions, etc.); and
  - Internal factors (personal problems, emotional stress, worry, etc.)

Inappropriate Response

- How a person responds in a given situation can cause or prevent an accident.
- Inappropriate response include:
  - A person detects a hazardous condition but does nothing to correct it;
  - A person removes a safeguard from a machine in an effort to increase output; or
  - A person disregards an established safety procedure
- Such responses can lead to accidents.

Inappropriate Activities

- Examples of inappropriate activities include:
  - A person undertaking a task he or she doesn't know how to do (performing tasks without requisite training)
  - A person misjudging the degree of risk involved in a given task and proceeding based on that misjudgment.



Human Factors Theory

Overload

- Fatigue
- Environmental factors
- Internal Factors
- Situational Factors

Inappropriate Response

- Detecting hazard but not correcting it
- Removing safeguards from machines & equipment
- Ignoring safety
- Misunderstanding the directions

Inappropriate Activities

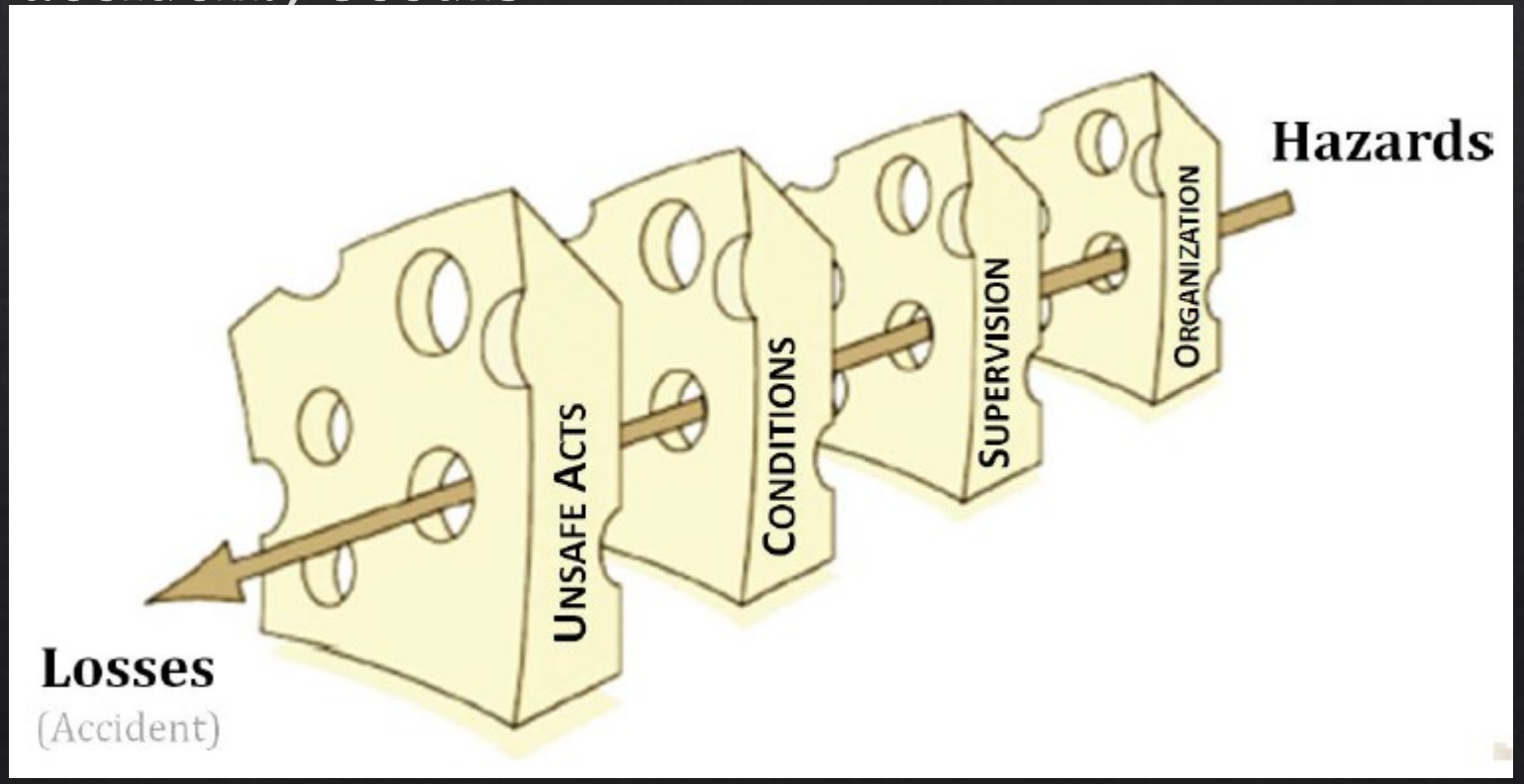
- Operating without authority
- Performing task without the requisite training
- Misjudging the degree of risk involved with a given tasks
- Horseplay

Swiss Cheese Model

- The Swiss Cheese Model of Accident Causation suggests that systemic failures, or accidents, occur from a series of events at different layers of an organization.
- A system is similar to slices of Swiss cheese
- There are holes which represent opportunities for failure, and each slice is a layer of the system.

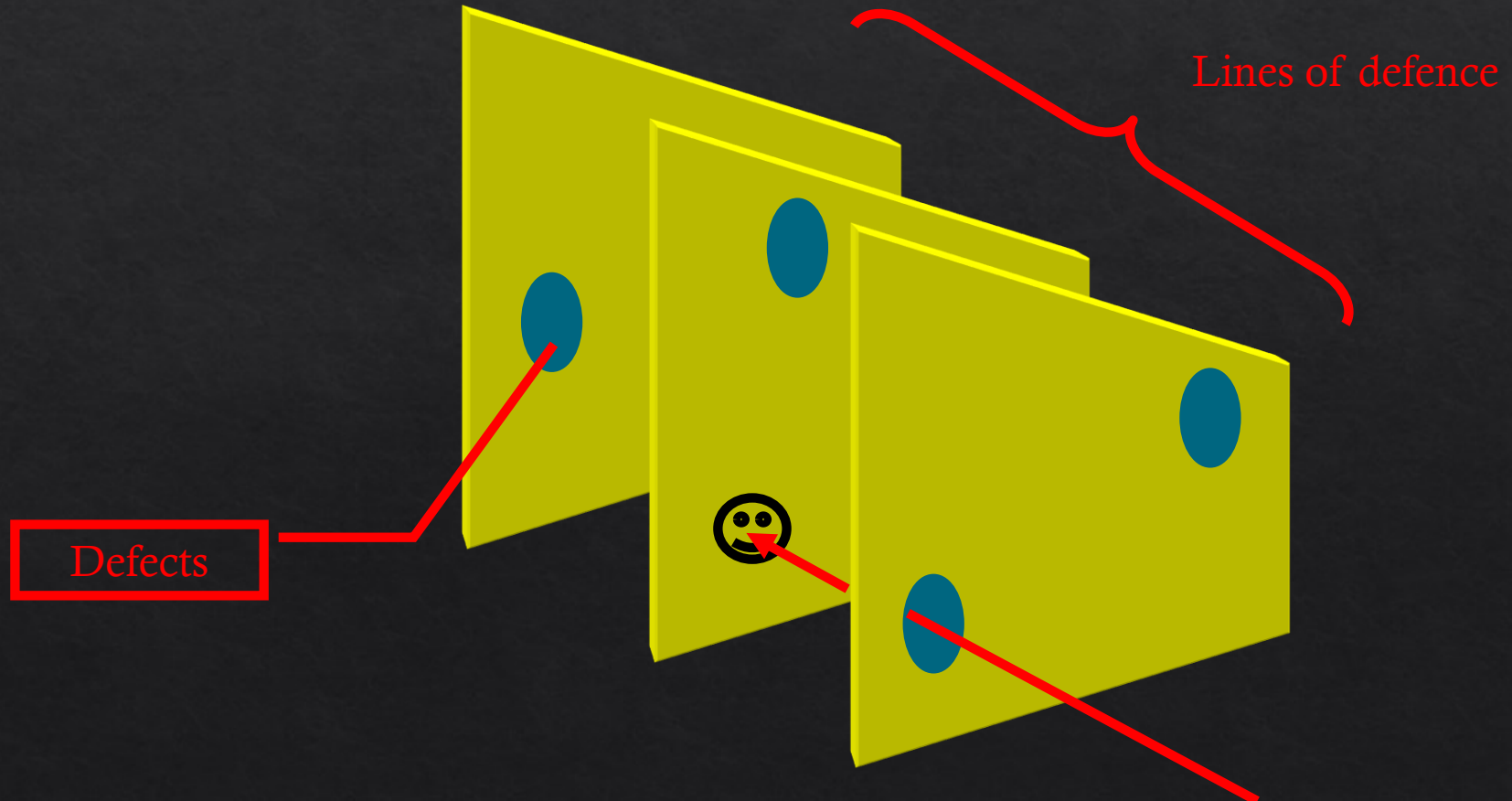
Swiss Cheese Model

- When holes in the layers line up, a loss (or accident) occurs

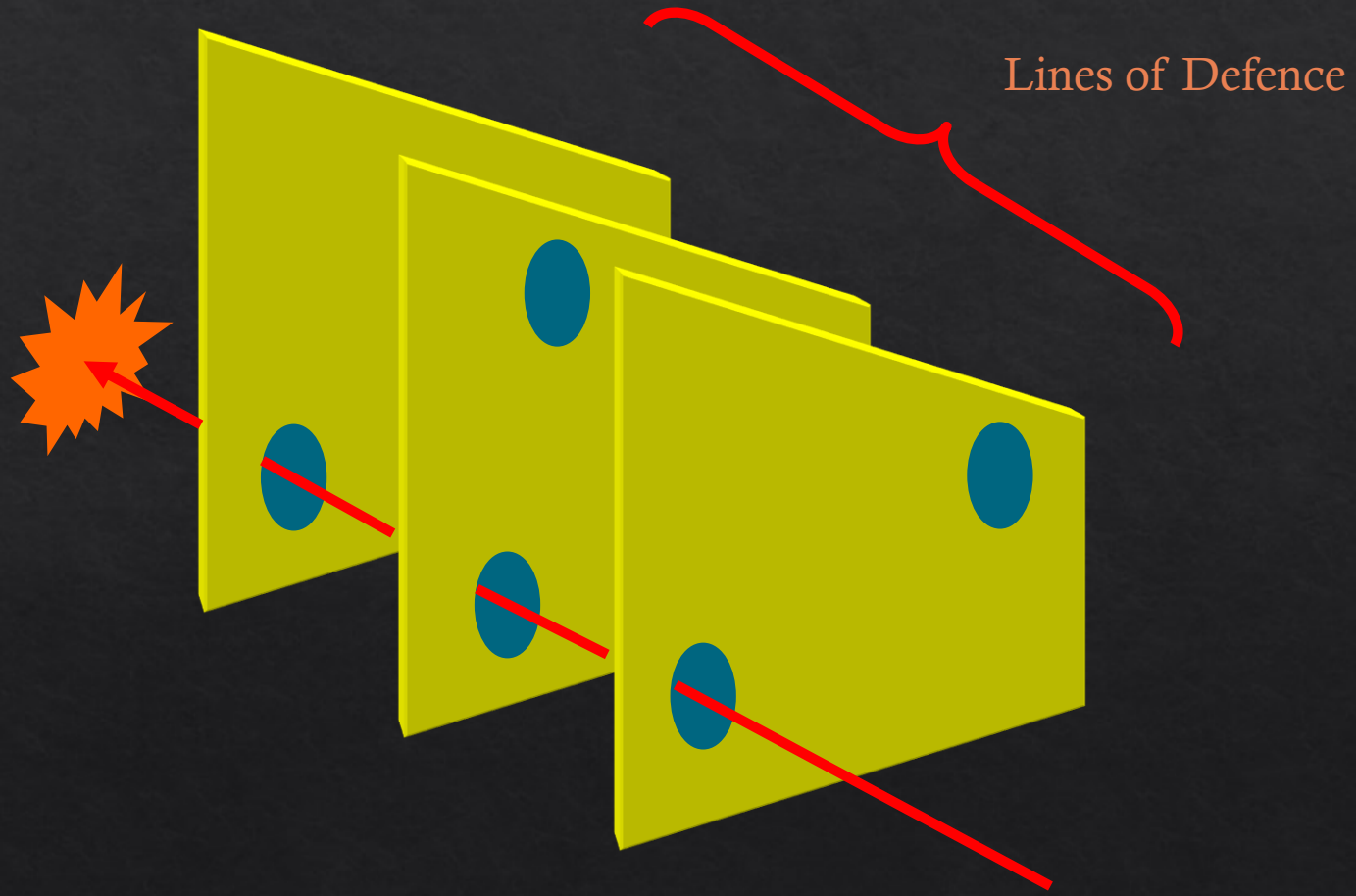


Swiss Cheese Model

- Each layer of the system is an opportunity to stop an error; the more layers, the less likely an accident is to occur.



Swiss Cheese Model



Learning from Past Experiences

- Kletz* recommended four ways for organisations to learn from past experience:
  - Recent and old accidents should be described in safety bulletins and discussed at safety meetings
  - standards and codes of practice should contain notes on accidents which led to the recommendations
  - a 'black book' containing reports of accidents with technical interest that have occurred should be compulsory reading for all newcomers and for refreshing memories
  - accident information retrieval and storage systems should be used as they contain a wealth of useful information

* Kletz, T. A. On the need to publish more case histories. Plant/Operations Progress, 1988, 7(3), 145-147.

Occupational Health and Safety Laws in Pakistan

- Main Laws in Pakistan are…

1. Factories Act, 1934.
2. Various Provincial Rules on the said subject.
3. Mines Act, 1923.
4. Workmen Compensation Act, 1923.
5. Dock Labourers Act, 1934.
6. The Employment of Children Act, 1991.
7. The Dock Workers(Regulations of Employment) Act, 1974.
8. Constitution of Pakistan, 1973.

Assignment

Write a report about a past major accident in the industry.

- Provide a detailed description of the accidents.
- Describe the reported causes.
- Discuss the lessons learnt from the accidents.

Due date will be announced soon!

End of the lecture!