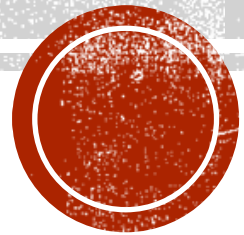
MCN401- INDUSTRIAL SAFETY ENGINEERING
MODULE-1



TEXTBOOKS

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5. Ronald P. Blake. (1973). Industrial safety. Prentice Hall, New Delhi.

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7. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai.

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MODULE-1 SYLLABUS

- **Module I (safety introduction):**
- Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.

THEORIES OF ACCIDENT CAUSATION

- There are several major theories concerning accident causation, each of which has some explanatory and predictive value.

1.The domino theory developed by H. W. Heinrich, a safety engineer and pioneer in the field of industrial accident safety.

2.Human Factors Theory

3.Accident/Incident Theory

4.Epidemiological Theory

5.Systems Theory

6.The energy release theory, developed by Dr. William Haddon, Jr., of the Insurance Institute for Highway Safety.

7.Behavior Theory Accident theories guide safety investigations.

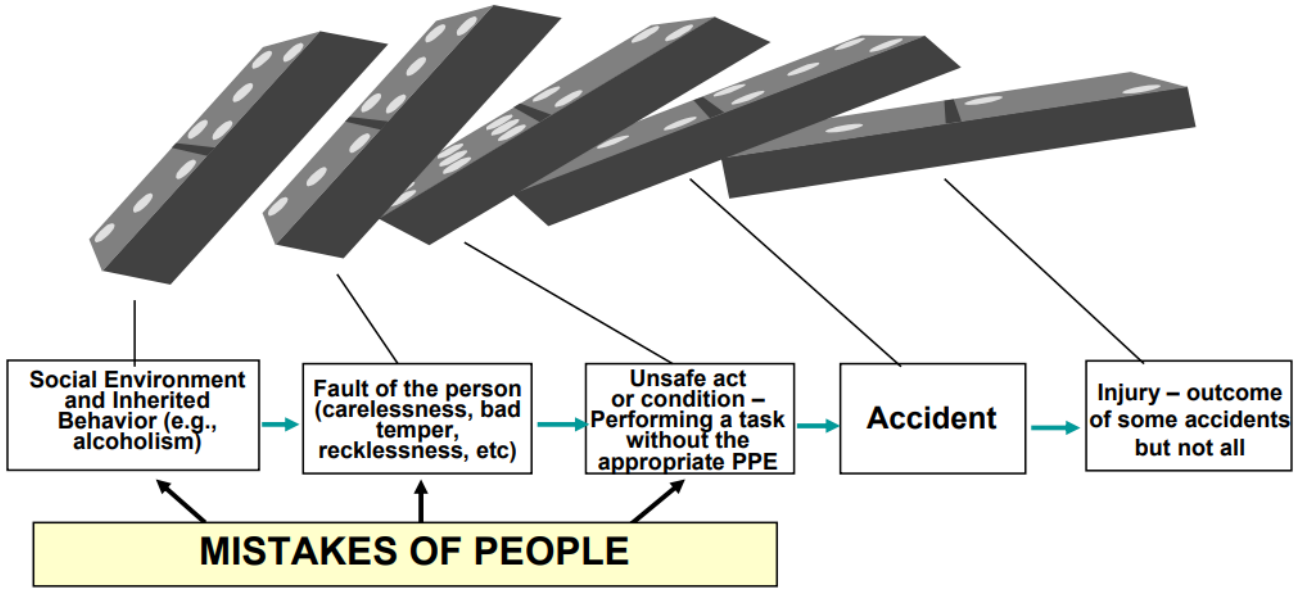
They describe the scope of an investigation

HEINRICH'S DOMINO THEORY

- According to Heinrich, an "accident" is one factor in a sequence that may lead to an injury.
- The factors can be visualized as a series of dominoes standing on edge; when one falls, the linkage required for a chain reaction is completed.
- Each of the factors is dependent on the preceding factor

HEINRICH'S DOMINO THEORY

1932 First Scientific Approach to Accident/Prevention - H.W. Heinrich



HEINRICH'S DOMINO THEORY

- Heinrich's Dominos – The Process
- 1. A personal injury (the final domino) occurs only as a result of an accident.
- 2. An accident occurs only as a result of a personal or mechanical hazard.
- 3. Personal and mechanical hazards exist only through the fault of careless persons or poorly designed or improperly maintained equipment.
- 4. Faults of persons are inherited or acquired as a result of their social environment or acquired by ancestry.
- 5. The environment is where and how a person was raised and educated.

HEINRICH'S DOMINO THEORY – CRITICAL ISSUES

- The factor preceding the accident (the unsafe act or the mechanical or physical hazard) and it should receive the most attention.

• Heinrich felt that the person responsible at a company for loss control should be interested in all five factors, but be concerned primarily with accidents and the proximate causes of those accidents.

• Heinrich also emphasized that accidents, not injuries or property damage, should be the point of attack. – An accident is any unplanned, uncontrolled event that could result in personal injury or property damage. For example, if a person slips and falls, an injury may or may not result, but an accident has taken place.

HEINRICH'S DOMINO THEORY – CORRECTIVE ACTION SEQUENCE (THE THREE "E"S)

- Engineering – Control hazards through product design or process change
- Education – Train workers regarding all facets of safety – Impose on management that attention to safety pays off
- Enforcement – Insure that internal and external rules, regulations, and standard operating procedures are followed by workers as well as management.

HUMAN FACTORS THEORY

- Heinrich posed his model in terms of a single domino leading to an accident. The premise here is that human errors cause accidents. These errors are categorized broadly as:
- OVERLOAD - The work task is beyond the capability of the worker

1. Includes physical and psychological factors

2. Influenced by environmental factors, internal factors, and situational factors

• INAPPROPRIATE WORKER RESPONSE - To hazards and safety measures (worker's fault) - To incompatible work station (management, environment faults)

• INAPPROPRIATE ACTIVITIES - Lack of training and misjudgment of risk.But the structure of this theory is still a cause/effect format.

ACCIDENT/INCIDENT THEORY

- Extension of human factors theory. Here the following new elements are introduced:

• Ergonomic traps – These are incompatible work stations, tools or expectations (management failure)

• Decision to err – Unconscious or conscious (personal failure)

• Systems failure – Management failure (policy, training, etc.)

EPIDEMIOLOGICAL THEORY

- Epidemiology :
- This field studies relationship between environmental factors and disease
- Can be used to study causal factors in a relationship Two key components:
- 1 Predisposition characteristics : tendencies may predispose worker to certain actions
- 2 Situational characteristics :peer pressure, poor attitude, risk taking Together these characteristics can cause or prevent accidents that a person predisposed to a given situation or condition may succumb to.

SUMMARY - TRADITIONAL CHAIN-OF-EVENTS ACCIDENT CAUSALITY MODELS

- Explain accidents in terms of multiple events, sequenced as a forward chain over time.
- Events linked together by direct relationships (ignore indirect relationships).
- Events almost always involve component failure, human error, or energy-related events.
- Causality models form the basis for most safety-engineering and reliability engineering analyses and/or designs.

LIMITATIONS OF EVENT-CHAIN CAUSALITY MODELS

- Neglects social and organizational factors
- Does not adequately account for human error
- One cannot simply and effectively model human behavior by decomposing it into individual decisions and actions. One cannot study human error in isolation from:
- physical and social context;
- value system in which behaviors takes place; and
- Dynamic work process
- Neglects adaptation – Major accidents involve systematic migration of organizational behavior to higher levels of risk.

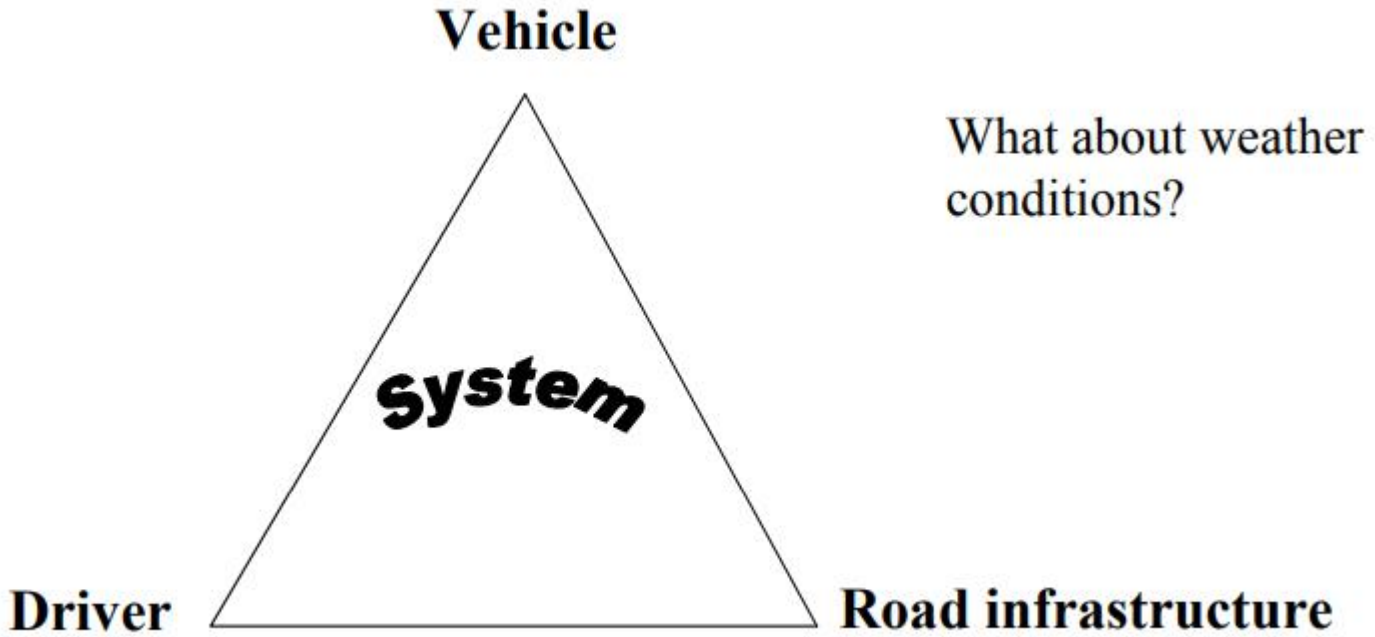
A SYSTEMS THEORY MODELS OF ACCIDENTS

- Accidents arise from interactions with humans, machines and the environment
- Not simply chains of events or linear casuality, but more complex types of casual connections
- Under normal circumstances chances of an accident is low. Rather than looking at the environment as being full of hazards and people prone to errors, system safety assumes harmony (steady state) exists between individuals and the work environment.

A SYSTEMS THEORY MODELS OF ACCIDENTS

- Safety is an emergent property that arises when components of system interact with each other within a larger environment.
  - A set of constraints related to behavior of components in system enforces that property.
  - Accidents when interactions violate those constraints (a lack of appropriate constraints on the interactions).
  - Software as a controller embodies or enforces those constraints.

SYSTEMS THEORY APPLIED TO TRANSPORTATION ENGINEERING



What about weather conditions?

SYSTEMS THEORY APPLIED TO TRANSPORTATION ENGINEERING

- Road accidents are seen as failures of the whole traffic system (interaction between the three elements) rather than a failure of the driver.
- The driver is a victim – this assumes the demands that the traffic system puts on the driver is too complex for th driver's limited capacity to process information.
- As a result of this assumption the system must be designed to be less complex, which prevents errors from occurring.
- "The energy and barriers perspective": The system must also reduce the negative consequences of errors, i.e., introduce safety margins that allows the driver to incur an error without being hurt too seriously.

HADDON'S ENERGY RELEASE THEORY

- Willam Haddon a medical doctor and the adminstrator of NHTSA at one point in time, in 1966 helped to impose the following regulations for new cars:

1. Seat belts for all occupants
2. Energy-absorbing steering column
3. Penetration-resistant windshield
4. Dual braking systems
5. Padded instrument panel
6. All measures correspond with the energy and barrier concept

HADDON'S ENERGY RELEASE THEORY

• The systems theory approach, in contrast to the energy release theory, treats the driver as a passive responder in his environment.

• The evidence is that he is in fact an active participant, regulating his/her level of preferred risk

• Risk compensation/ behavioural adaptation: operators within a system may take advantage of safety measures in other ways than to increase safety

• Two basic forms of compensation to road safety measures:

– Increased speed

– Reduced attention

SYSTEMS MODEL - SUMMARY

- Views accidents as a control problem

  e.g., O–ring did not control propellant gas release by sealing gap in field joint

  Software did not adequately control descent speed of Mars Polar Lander.

- Events are the result of the inadequate control

  Result from lack of enforcement of safety constraints

- To understand accidents, need to examine control structure itself to determine why inadequate to maintain safety constraints and why events occurred.

Not a "blame" model – trying to understand "why"

BEHAVIORAL THEORY

- Often referred to as behavior-based safety (BBS)
- 7 basic principles of BBS
  - Intervention
  - Identification of internal factors
  - Motivation to behave in the desired manner
  - Focus on the positive consequences of appropriate behavior
  - Application of the scientific method
  - Integration of information
  - Planned interventions

COMBINATION THEORY

- Accidents may/may not fall under any one model
- Result from factors in several models.
- One model cannot be applied to all accidents