

# ACCIDENT CAUSATION

Iranian Occup Health & Safety



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# *Early Man*

# *Industrial Revolution*

**Factory managers reasoned that  
workers were hurt because —  
Number is Up**



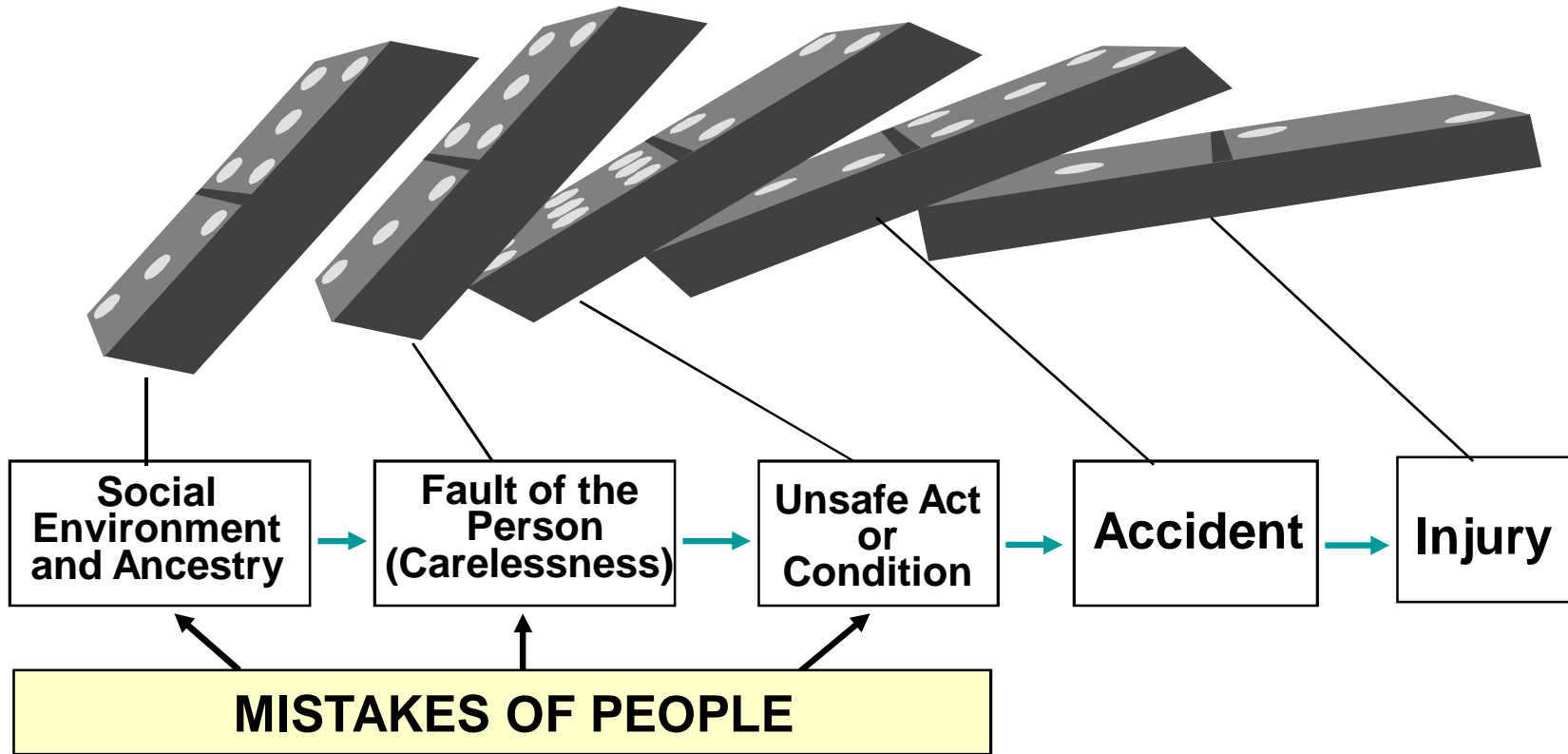
**PEOPLE PROBLEM**

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# Domino Theory

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



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# Heinrich's Theorems

- **INJURY** - caused by accidents.
- **ACCIDENTS** - caused by an unsafe act – injured person or an unsafe condition – work place.
- **UNSAFE ACTS/CONDITIONS** - caused by careless persons or poorly designed or improperly maintained equipment.
- **FAULT OF PERSONS** - created by social environment or acquired by ancestry.
- **SOCIAL ENVIRONMENT/ANCESTRY** - where and how a person was raised and educated.

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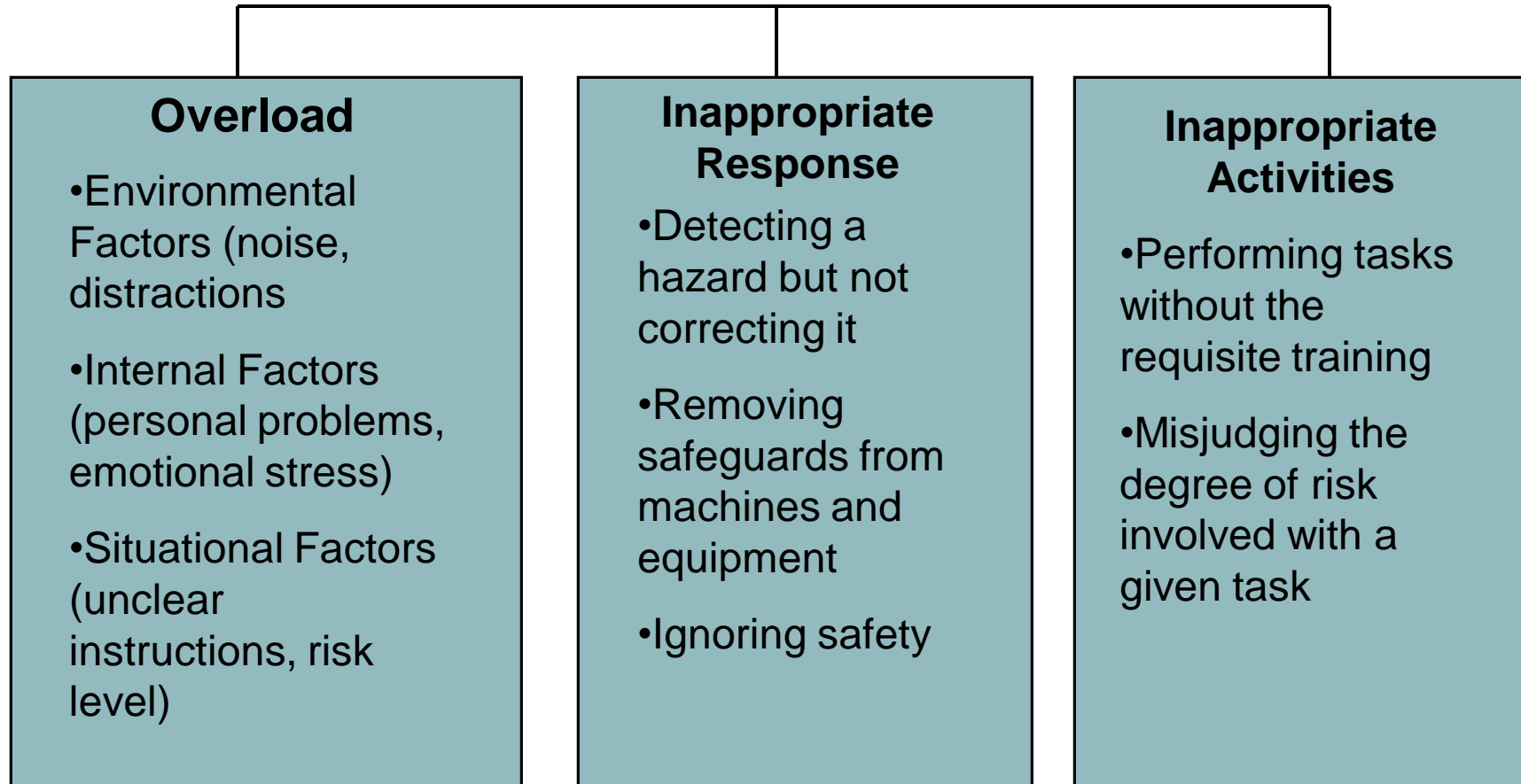
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# *Heinrich's Theory*

- **Corrective Action Sequence  
(The three “E”s)**

**Engineering  
Education  
Enforcement**

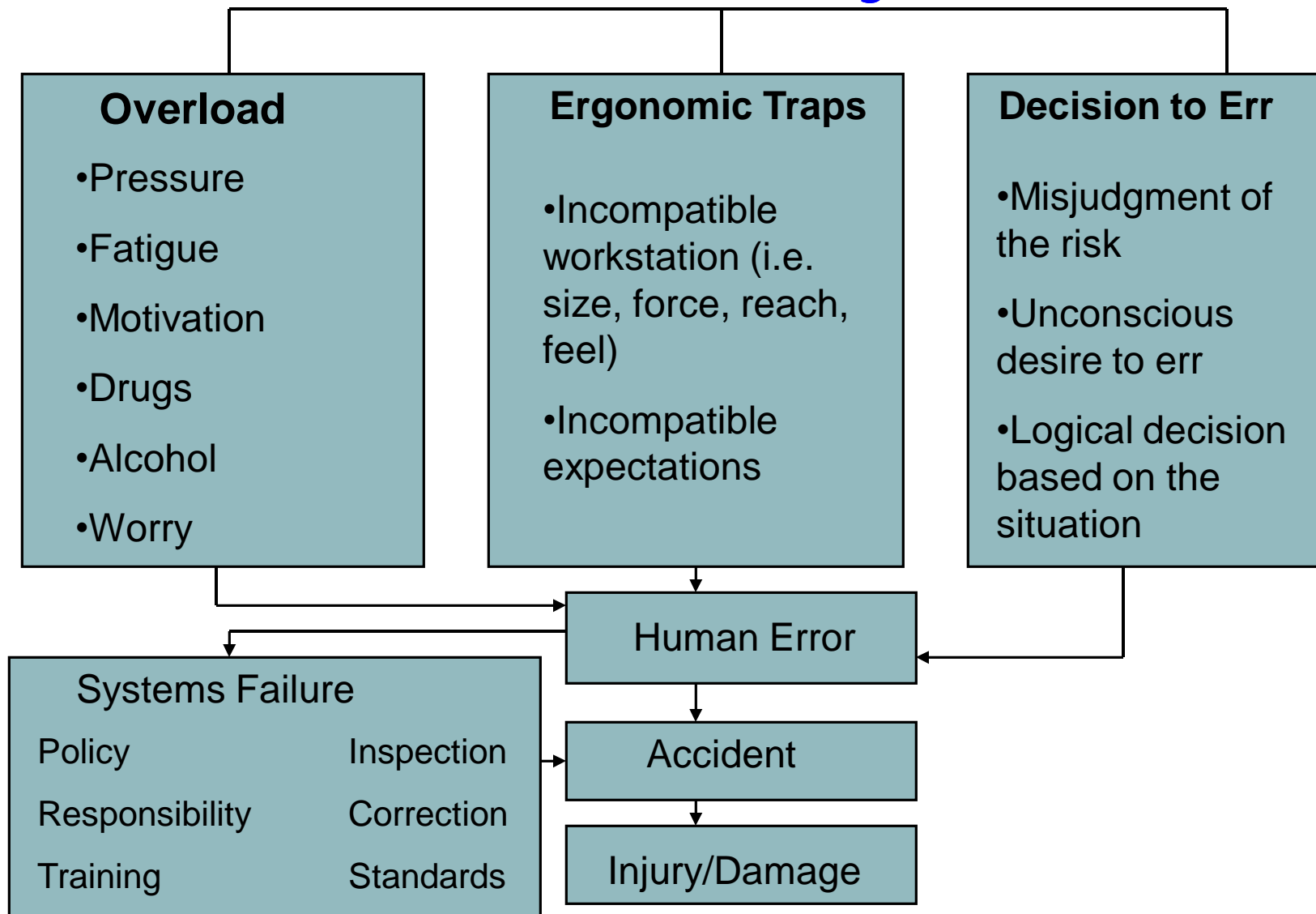
# Human Factors Theory



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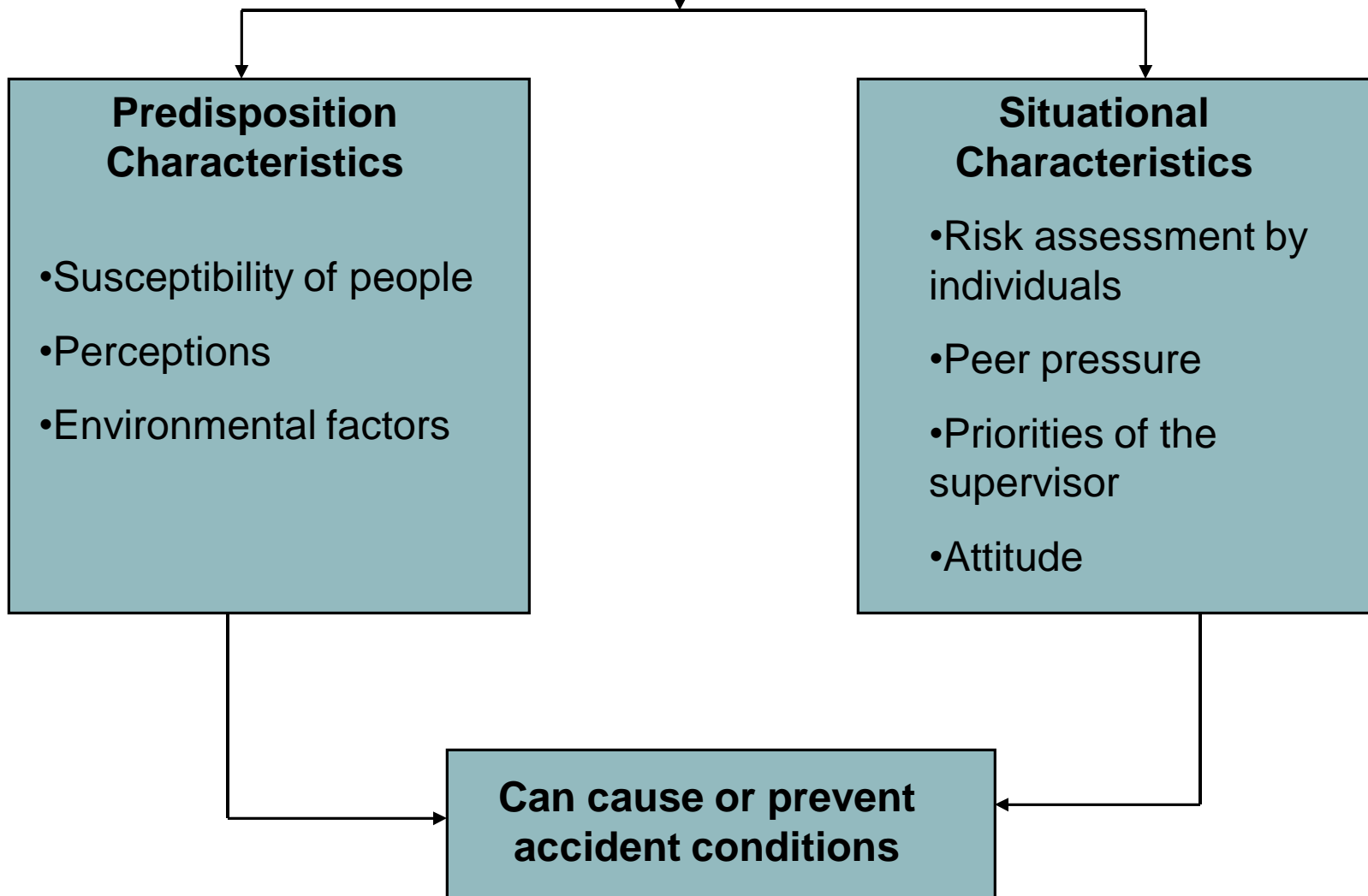
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# Petersen's Accident/Incident Theory



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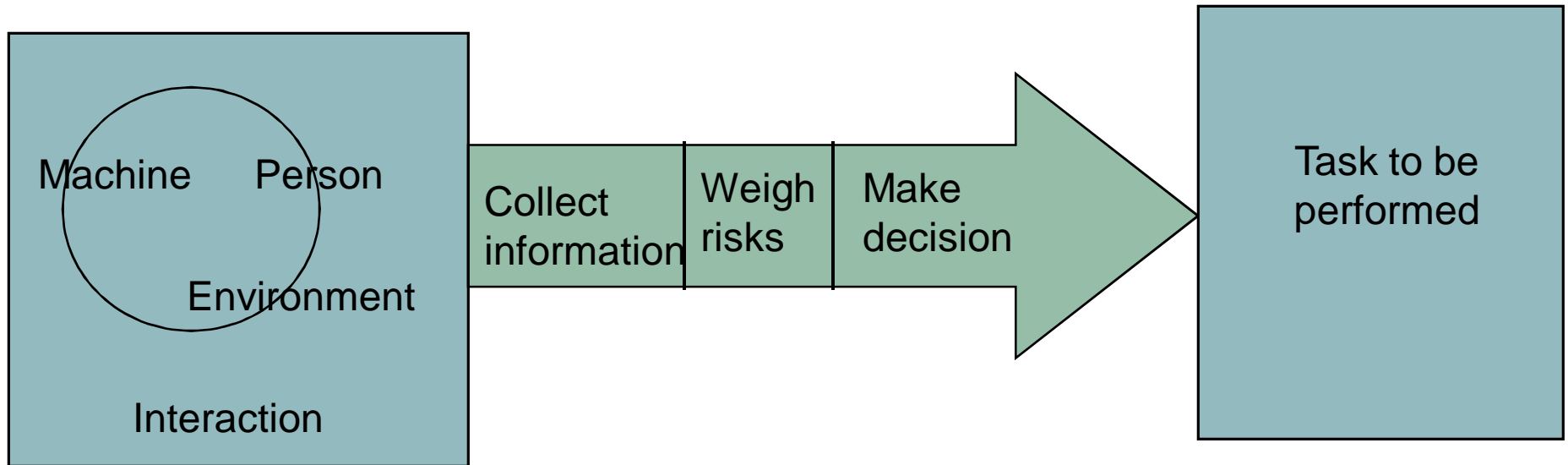
# Epidemiological Theory



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# Systems Theory Model



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# Combination Theory

- For some accidents, a given model may be very accurate, for others less so
- Often the cause of an accident cannot be adequately explained by just one model/theory
- Actual cause may combine parts of several different models

# 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

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## Epidemiological Model Example

Jane Andrews was the newest member of the loading unit for Parcel Delivery Service (PDS). She and the other members of her unit were responsible for loading 50 trucks every morning. It was physically demanding work, and she was the first woman ever selected by PDS to work in the loading unit. She had gotten the job as part of the company's upward mobility program. She was excited about her new position because within PDS, the loading unit was considered a springboard to advancement. Consequently, she was anxious to do well. The responsibility she felt toward other female employees at PDS only served to intensify her anxiety. Andrews felt that if she failed, other women might not get a chance to try in the future.

Before beginning work in the loading unit, employees must complete two days of training on proper lifting techniques. The use of back-support belts is mandatory for all loading dock personnel. Consequently, Andrews became concerned when the supervisor called her aside on her first day in the unit and told her to forget what she had learned in training. He said, "Jane, nobody wants a back injury, so be careful. But the key to success in this unit is speed. The lifting techniques they teach you in that workshop will just slow you down. You've got the job, and I'm glad you're here. But you won't last long if you can't keep up."

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## Epidemiological Model Example (continued)

Andrews was torn between following safety procedures and making a good impression on her new supervisor. At first, she made an effort to use proper lifting techniques. However, when several of her co-workers complained that she wasn't keeping up, the supervisor told Andrews to "keep up or get out of the way." Feeling the pressure, she started taking the same shortcuts she had seen her co-workers use. Positive results were immediate, and Andrews received several nods of approval from fellow workers and a "good job" from the supervisor. Before long, Andrews had won the approval and respect of her colleagues.

However, after two months of working in the loading unit, she began to experience persistent lower back pain. Andrews felt sure that her hurried lifting techniques were to blame, but she valued the approval of her supervisor and fellow workers too much to do anything that might slow her down. Finally, one day while loading a truck, she fell to the pavement in pain and could not get up. Her back throbbed with intense pain, and her legs were numb. She had to be rushed to the emergency room of the local hospital. By the time she was checked out of the hospital a week later, she had undergone major surgery to repair two ruptured discs.

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## Systems Theory Example

Precision Tooling Company (PTC) specializes in difficult orders that are produced in small lots, and in making corrections to parts that otherwise would wind up as expensive rejects in the scrap bin. In short, PTC specializes in doing the types of work that other companies cannot, or will not do. Most of PTC's work comes in the form of subcontracts from larger manufacturing companies. Consequently, living up to its reputation as a high performance, on-time company is important to PTC.

Because much of its work consists of small batches of parts to be reworked, PTC still uses several manually operated machines. The least experienced machinists operate these machines. This causes two problems. The first problem is that it is difficult for even a master machinist to hold to modern tolerance levels on these old machines. Consequently, apprentice machinists find holding to precise tolerances quite a challenge. The second problem is that the machines are so old that they frequently break down.

Complaints from apprentice machinists about the old machines are frequent. However, their supervisors consider time on the old "ulcer makers" to be one of the rites of passage that upstart machinists must endure. Their attitude is, "We had to do it, so why shouldn't you?" This was where things stood at PTC when the company won the Johnson contract.

## Systems Theory Example continued

PTC had been trying for years to become a preferred supplier for H.R. Johnson Company. PTC's big chance finally came when Johnson's manufacturing division incorrectly produced 10,000 copies of a critical part before noticing the problem. Simply scrapping the part and starting over was an expensive solution. Johnson's vice-president for manufacturing decided to give PTC a chance.

PTC management was ecstatic! Finally, they had won an opportunity to partner with H.R. Johnson Company. If PTC could perform well on this one, even more lucrative contracts were sure to follow. The top managers called a company-wide meeting of all employees. Attendance was mandatory.

The CEO explained to the employees that the contract was a great opportunity for the company to move into the stratosphere. However, the parts that needed reworking would have to go through several manual operations in the beginning of the process. So, he explained that the manual machine operators would have to be the heroes for this particular job; and, the parts have to be ready in 90 days.

The PTC apprentice machinists were on the spot. If PTC didn't perform on this contract, it would be their fault.

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## Combination Theory Example

Crestview Grain Corporation (CGC) maintains ten large silos for storing corn, rice, wheat, barley, and various other grains. Since stored grain generates fine dust and gases, ventilation of the silos is important. Consequently, all of CGC's silos have several large vents. Each of these vents uses a filter similar to the type used in home air conditioners that must be changed periodically.

There is an element of risk involved in changing the vent filters because of two potential hazards. The first hazard comes from unvented dust and gases that can make breathing difficult, or even dangerous. The second hazard is the grain itself. Each silo has a catwalk that runs around its inside circumference near the top. These catwalks give employees access to the vents that are also near the top of each silo. The catwalks are almost 100 feet above ground level, they are narrow, and the guardrails on them are only knee high. A fall from a catwalk into the grain below would probably be fatal.

Consequently, CGC has well-defined rules that employees are to follow when changing filters. Because these rules are strictly enforced, there had never been an accident in one of CGC's silos; not, that is, until the Juan Perez tragedy occurred. Perez was not new to the company. At the time of his accident, he had worked at CGC for over five years. However, he was new to the job of silo maintenance. His inexperience, as it turned out, would prove fatal.

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## Combination Theory Example Continued

It was time to change the vent filters in silo number 4. Perez had never changed vent filters himself. He hadn't been in the job long enough. However, he had served as the required "second man" when his supervisor, Bao Chu Lai, had changed the filters in silos 1, 2, and 3. Since Chu Lai was at home recuperating from heart surgery and would be out for another four weeks, Perez decided to change the filters himself. Changing the filters was a simple enough task, and Perez had always thought the "second man" concept was overdoing it a little. He believed in taking reasonable precautions as much as the next person, but in his opinion, CGC was paranoid about safety.

Perez collected his safety harness, respirator, and four new vent filters. Then he climbed the external ladder to the entrance/exit platform near the top of silo number 4. Before going in, Perez donned his respirator and strapped on his safety harness. Opening the hatch cover, he stepped inside the silo onto the catwalk. Following procedure, Perez attached a lifeline to his safety harness, picked up the new vent filters, and headed for the first vent. He changed the first two filters without incident. It was while he was changing the third filter that tragedy struck.

The filter in the third vent was wedged in tightly. After several attempts to pull it out, Perez became frustrated and gave the filter a good jerk. When the filter suddenly broke loose, the momentum propelled him backwards and he toppled off the catwalk. At first it appeared that his lifeline would hold, but without a second person to pull him up or call for help, Perez was suspended by only the lifeline for over 20 minutes. He finally panicked, and in his struggle to pull himself up, knocked the buckle of his safety harness open. The buckle gave way, and he fell over 50 feet into the grain below. The impact knocked his respirator off, the grain quickly enveloped him, and he was asphyxiated.

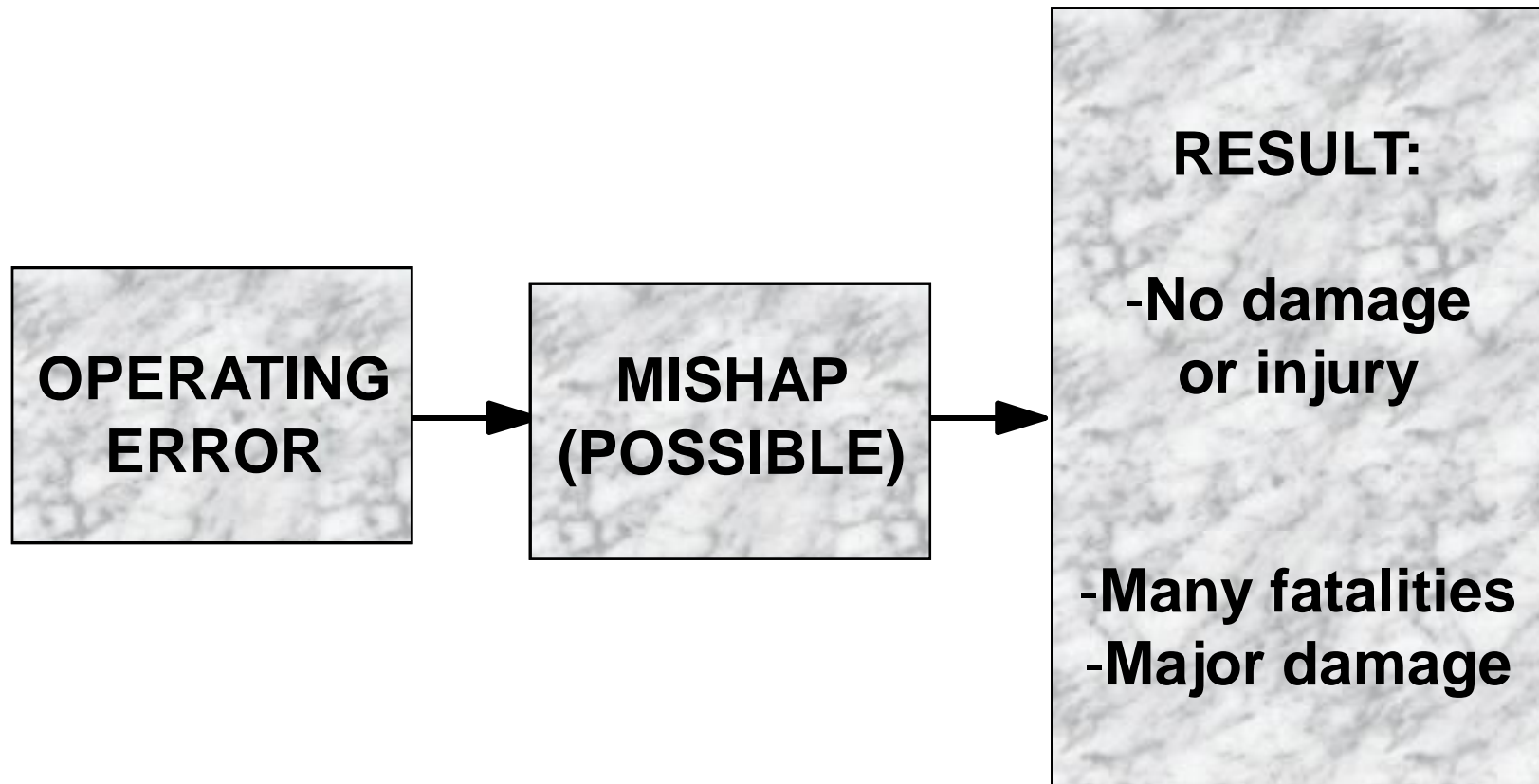
## Behavioral Theory Example

Mark Potter is the safety manager for Excello Corporation. Several months ago, he became concerned because employees seemed to have developed a lax attitude toward wearing hard hats. What really troubled Potter was that there is more than the usual potential for head injuries because of the type of work done in Excello's plant, and he had personally witnessed two near misses in less than a week. An advocate of behavior-based safety (BBS), he decided to apply the ABC model in turning this unsafe behavior pattern around.

His first step was to remove all of the old "Hard Hat Area" signs from the plant and replace them with newer, more noticeable signs. Then he scheduled a brief seminar on head injuries and cycled all employees through it over a two-week period. The seminar took an unusual approach. It told a story of two employees. One was in a hospital bed surrounded by family members he did not even recognize. The other was shown enjoying a family outing with happy family members. The clear message of the video was "the difference between these two employees is a hard hat." These two activities were the antecedents to the behavior he hoped to produce (all employees wearing hard hats when in a hard hat area).

The video contained a powerful message and it had the desired effect. Within days, employees were once again disciplining themselves to wear their hard hats (the desired behavior). The consequence was that near misses stopped and no head injuries have occurred at Excello in months. The outcome of this is that Excello's employees have been able to continue enjoying the fruits of their labor and the company of loved ones.

# *Modern Causation Model*



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# *Examples*

## **Operating Errors:**

- § **Being in an unsafe position**
- § **Stacking supplies in unstable stacks**
- § **Poor housekeeping**
- § **Removing a guard**

# *Systems Defect*

- **Revolutionized accident prevention**
- **A weakness in the design or operation of a system or program**

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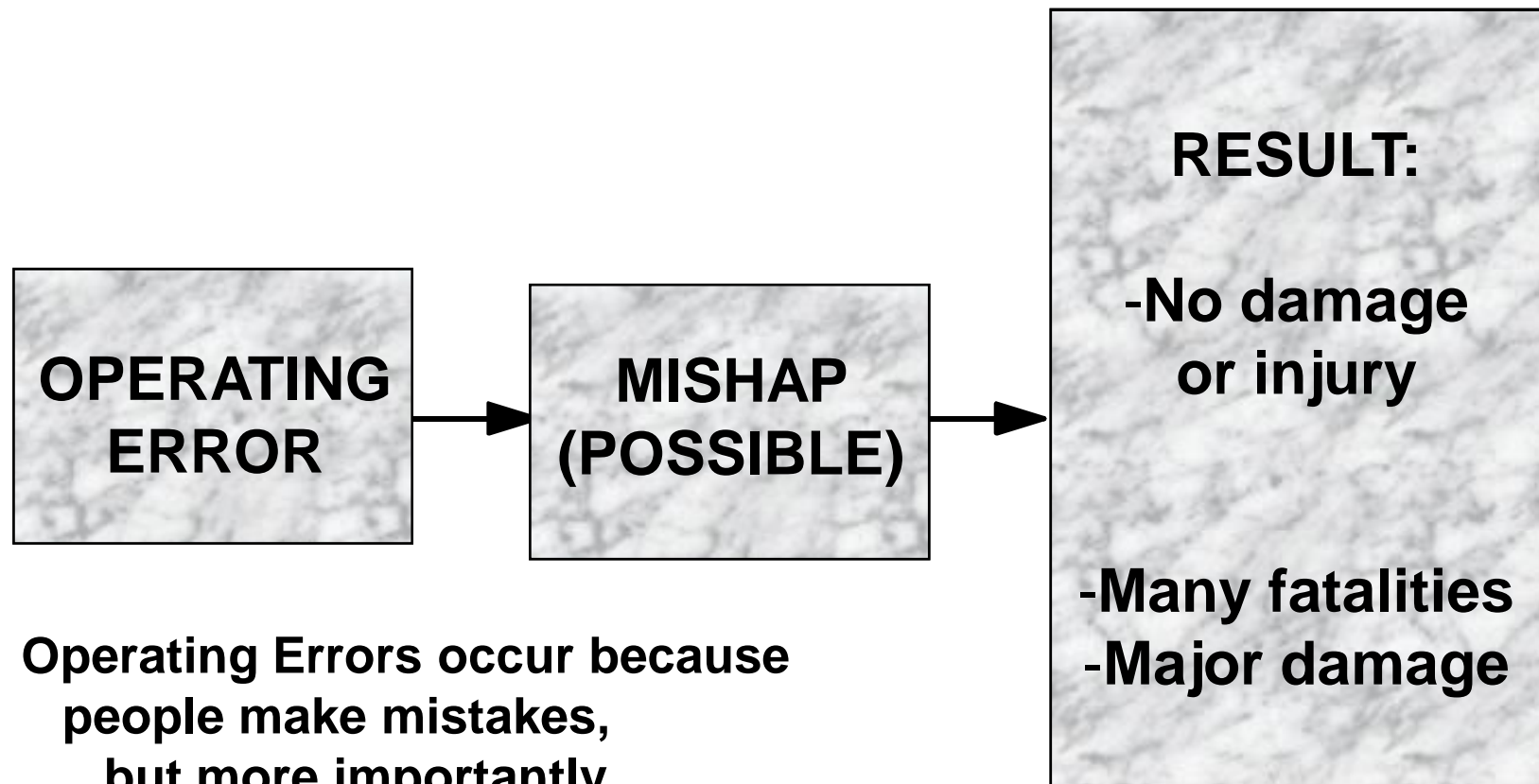
# *Examples*

- **Systems defects include:**
  - **Improper assignment of responsibility**
  - **Improper climate of motivation**
  - **Inadequate training and education**
  - **Inadequate equipment and supplies**
  - **Improper procedures for the selection & assignment of personnel**
  - **Improper allocation of funds**

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# Modern Causation Model

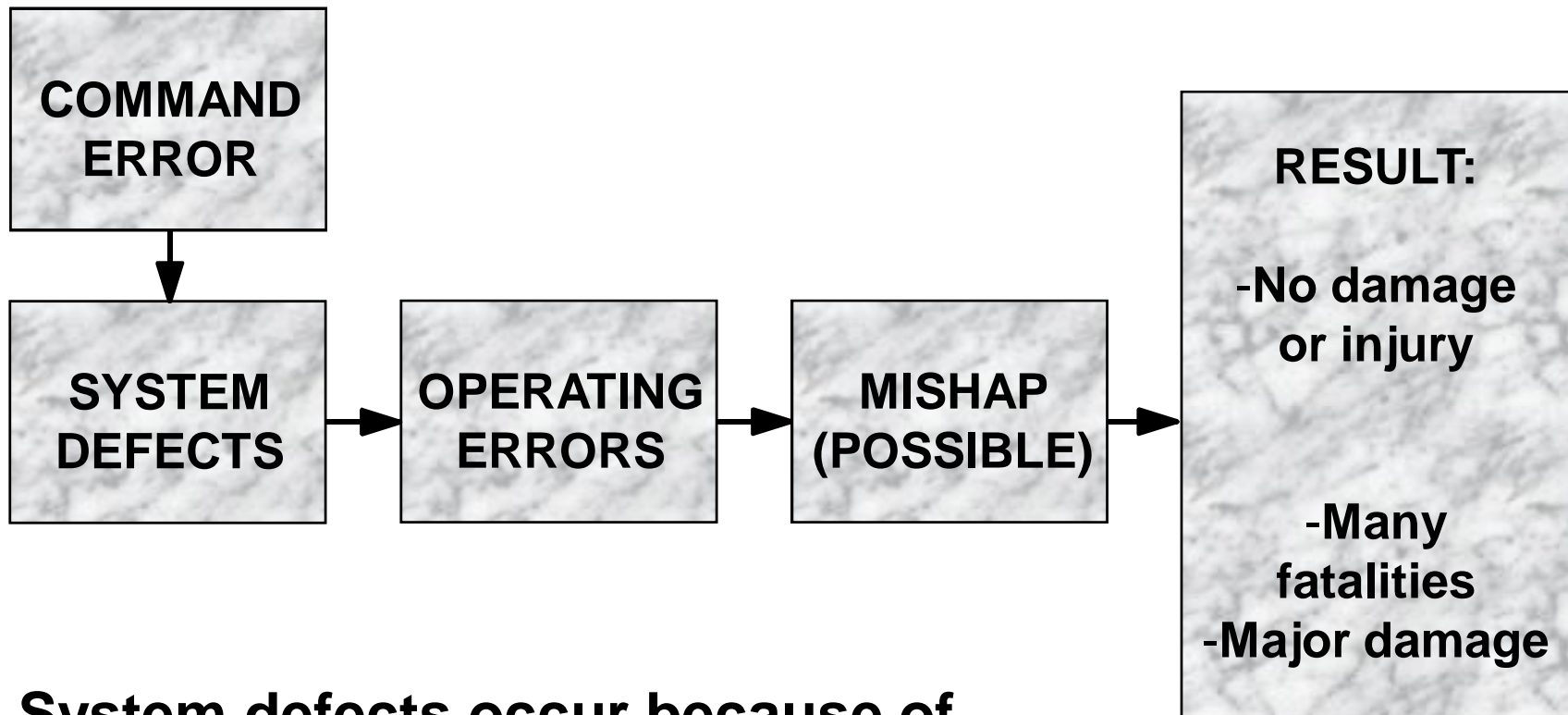


Operating Errors occur because people make mistakes, but more importantly, they occur because of

***SYSTEM DEFECTS***

# Modern Causation Model

Managers design the Systems



System defects occur because of

***MANAGEMENT / COMMAND ERROR***

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# *Safety Program Defect*

**A defect in some aspect of the safety program that allows an avoidable error to exist.**

- Ineffective Information Collection**
- Weak Causation Analysis**
- Poor Countermeasures**
- Inadequate Implementation Procedures**
- Inadequate Control**

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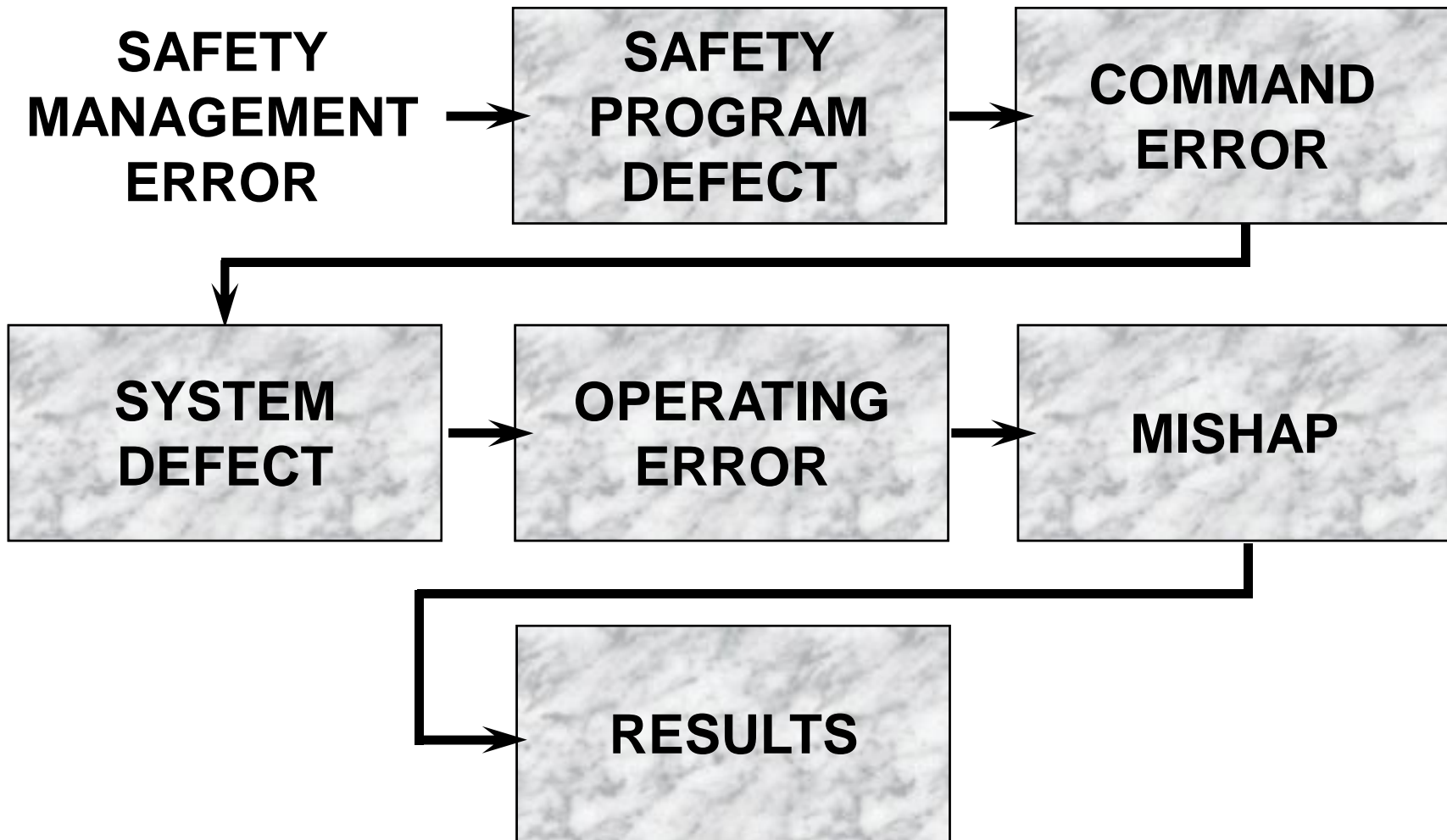
# *Safety Management Error*

**A weakness in the knowledge or motivation of the safety manager that permits a preventable defect in the safety program to exist.**



**SAFETY  
MANAGEMENT  
ERROR**

# *Modern Causation Model*

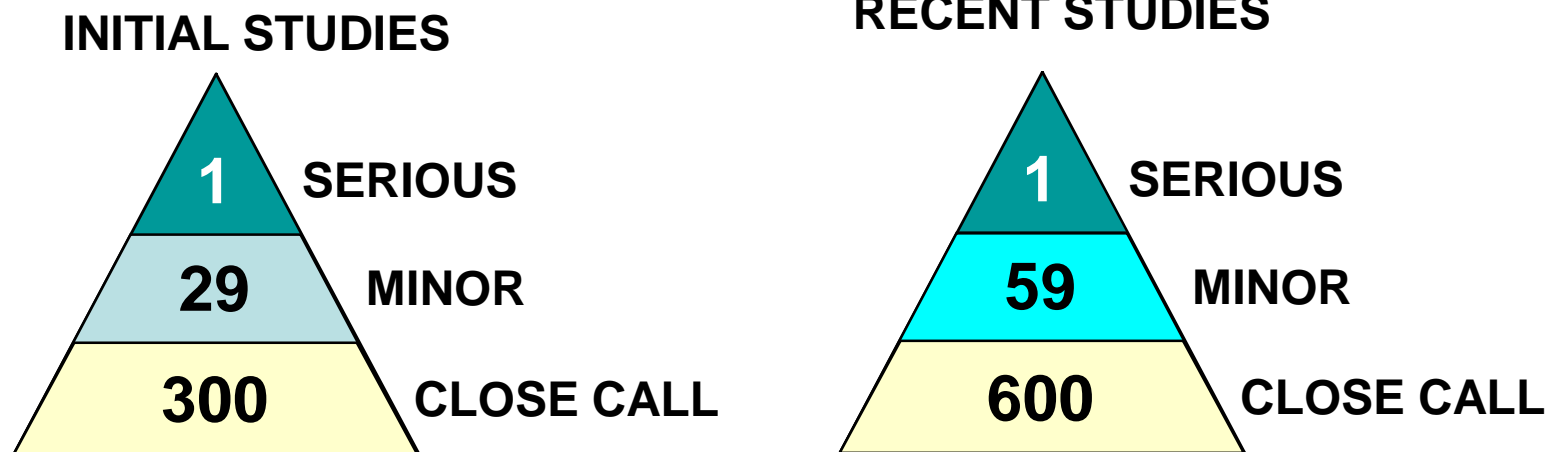


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# *Near-Miss Relationship*

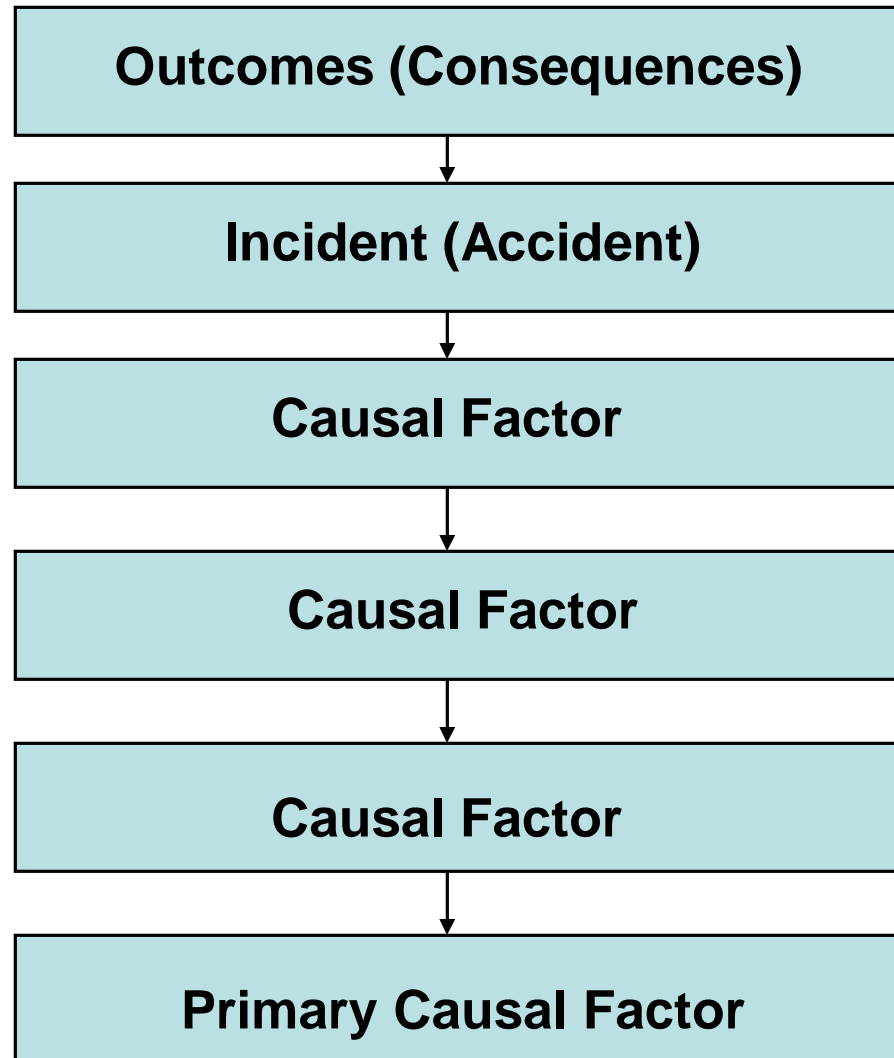
- | Initial studies show for each disabling injury, there were 29 minor injuries and 300 close calls/no injury.
- | Recent studies indicate for each serious result there are 59 minor and 600 near-misses.



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# Iceberg Principle



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# *Seven Avenues*

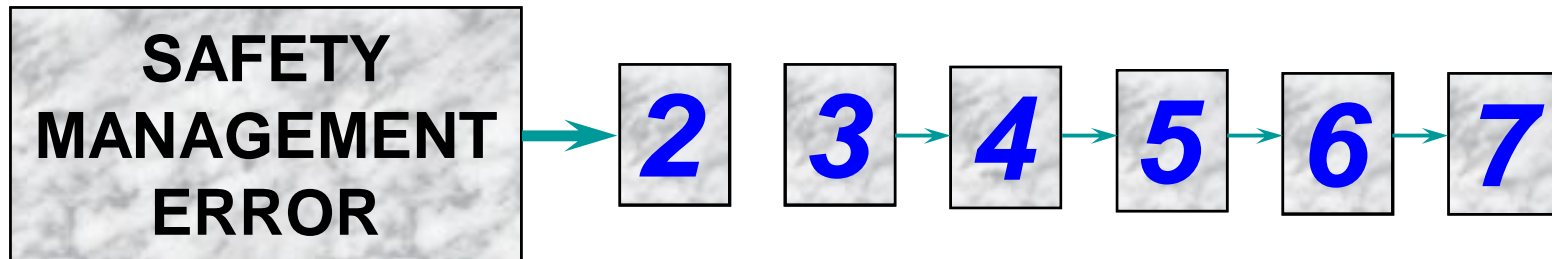
**There are seven avenues through which we can initiate countermeasures. They are:**

- § Safety management error**
- § Safety program defect**
- § Management / Command error**
- § System defect**
- § Operating error**
- § Mishap**
- § Result**

# Seven Avenues

Potential countermeasures for each modern causation approach include:

1



TRAINING  
EDUCATION  
MOTIVATION  
TASK DESIGN

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# Seven Avenues

Potential countermeasures for each modern causation approach include:

**2**



REVISE INFORMATION  
COLLECTION  
ANALYSIS  
IMPLEMENTATION

# *Seven Avenues*

**Potential countermeasures for each modern causation approach include:**

**3**



**TRAINING  
EDUCATION  
MOTIVATION  
TASK DESIGN**

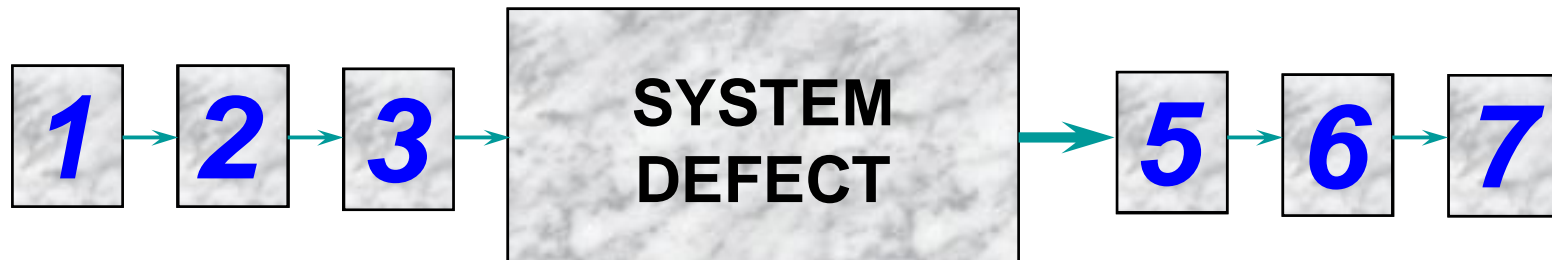
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# Seven Avenues

Potential countermeasures for each modern causation approach include:

**4**



**DESIGN REVISION VIA--**

- SOP
- REGULATIONS
- POLICY LETTERS
- STATEMENTS

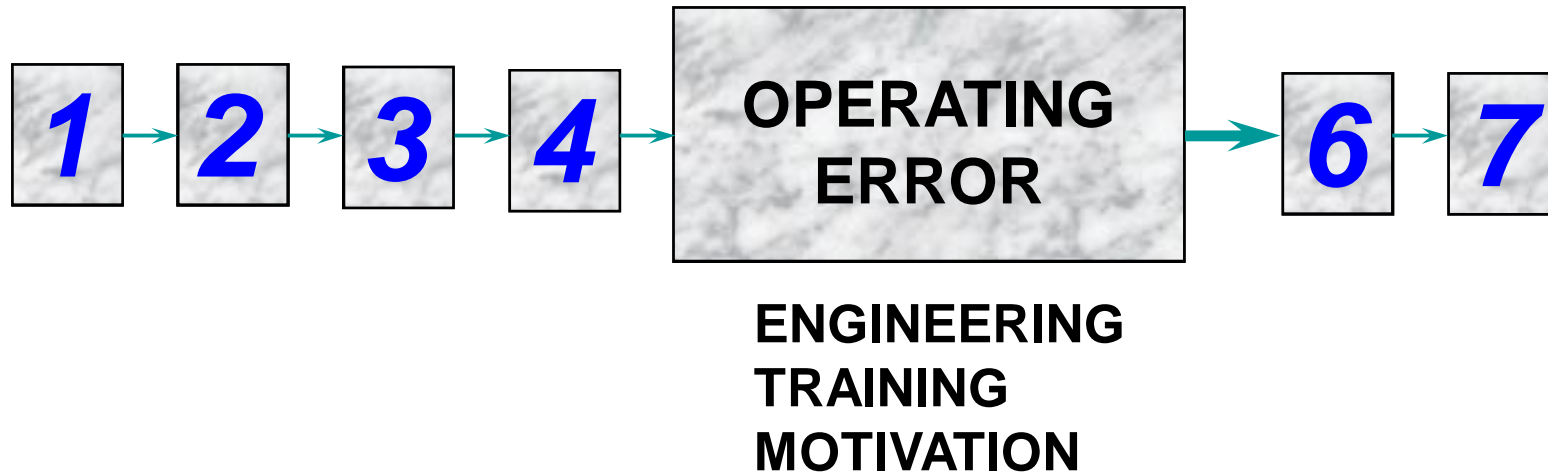
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# *Seven Avenues*

**Potential countermeasures for each modern causation approach include:**

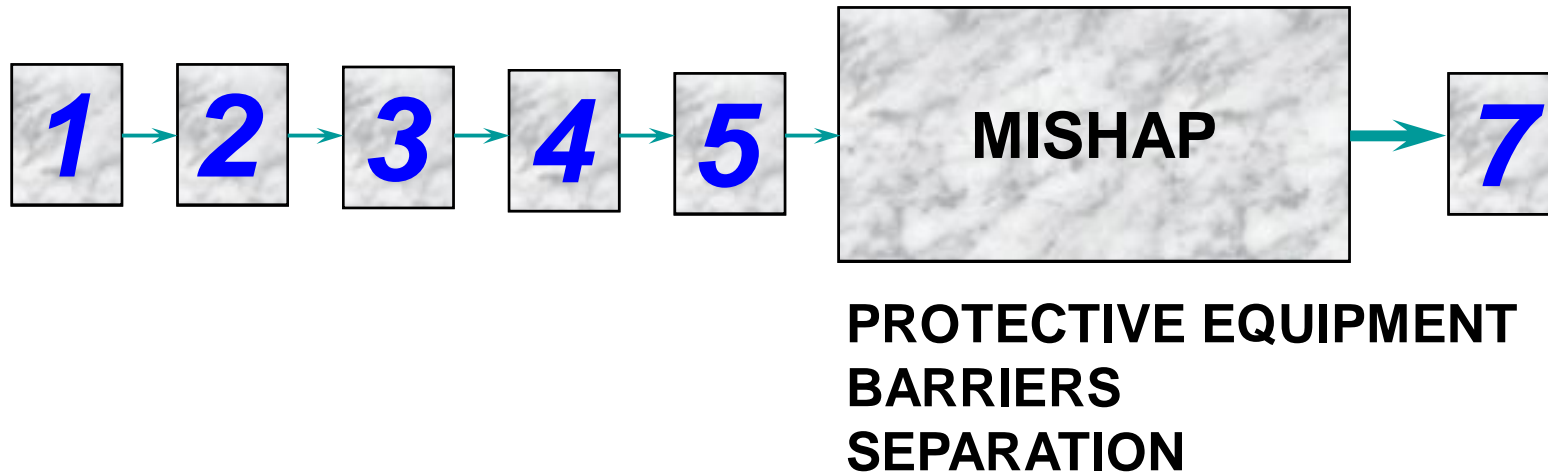
**5**



# *Seven Avenues*

**Potential countermeasures for each modern causation approach include:**

**6**



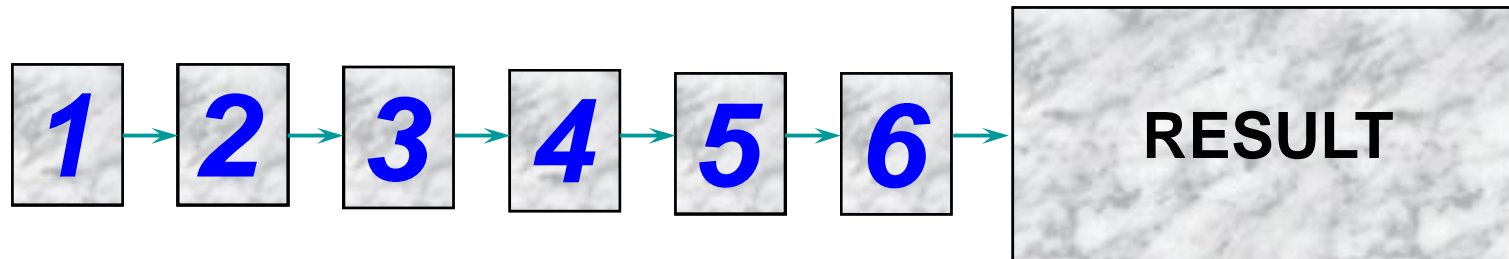
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# *Seven Avenues*

**Potential countermeasures for each modern causation approach include:**

**7**



**CONTAINMENT  
FIREFIGHTING  
RESCUE  
EVACUATION  
FIRST AID**

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# Human Factors Model

**A system is simply a group of interrelated parts which, when working together as they were designed to do, accomplish a goal. Using this analogy, an installation or organization can be viewed as a system.**

**The elements of the Human Factors Model are:**

- § Task**
- § Person**
- § Tools/Technology**
- § Environment**
- § Organization**

# Human Factors Model

- Tasks
  - Content
  - Demands
  - Control
  - Interrelationships

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# Human Factors Model

- Person
  - Attributes
  - Skills
    - Have knowledge and skill to apply the knowledge
  - Needs
  - Motivations
  - Intelligence

# Human Factors Model

- Tools/Technology
  - Functions
  - Capabilities
  - Capacities
  - Usability
  - Friendliness
  - Integration

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# Human Factors Model

- Organizations
  - Purposes
  - Policies
  - Procedures

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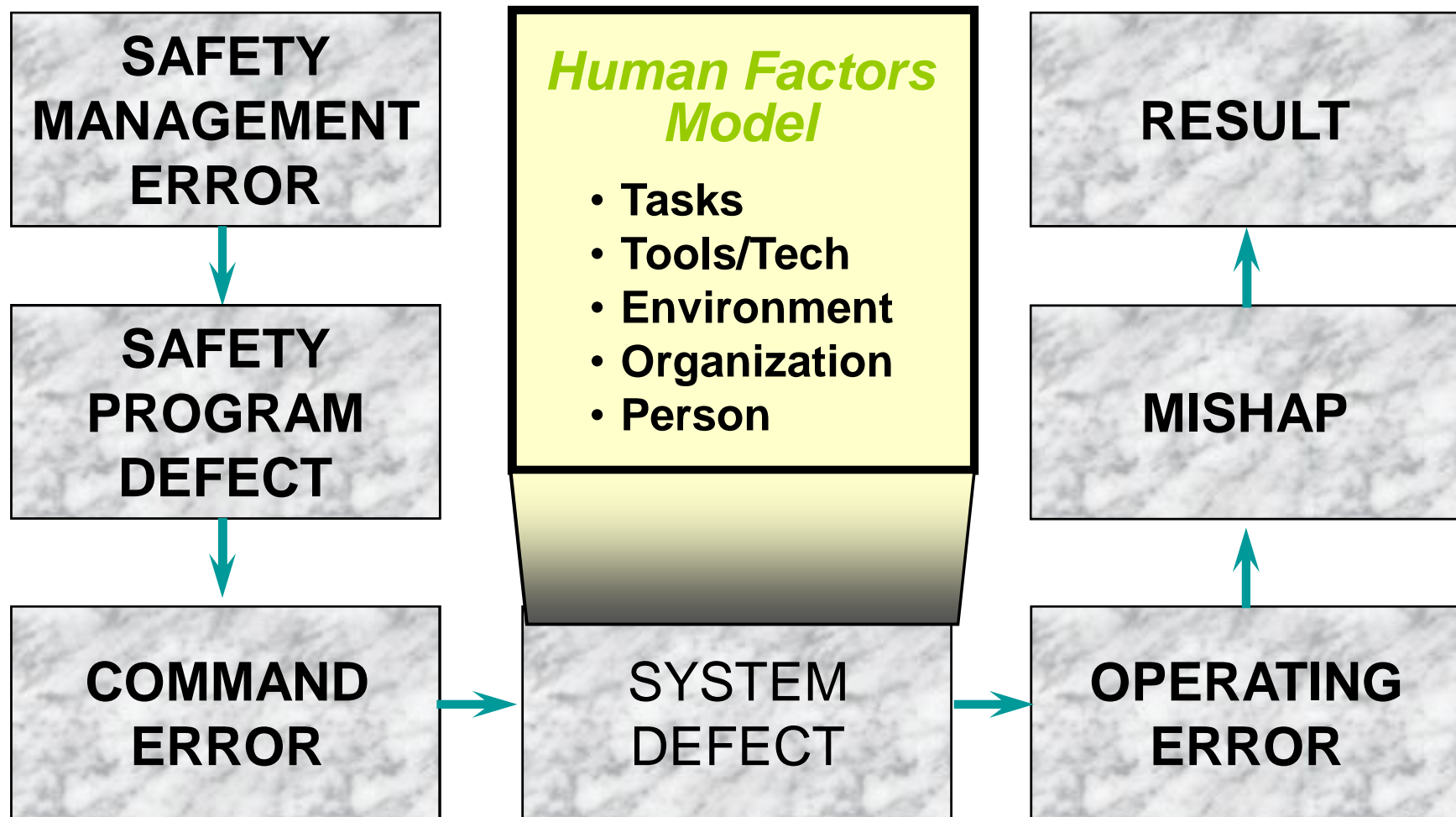
# Human Factors Model

- Environment
  - Physical
    - Noise
    - Weather
    - Facilities
    - Lighting
    - Ventilation
  - Social

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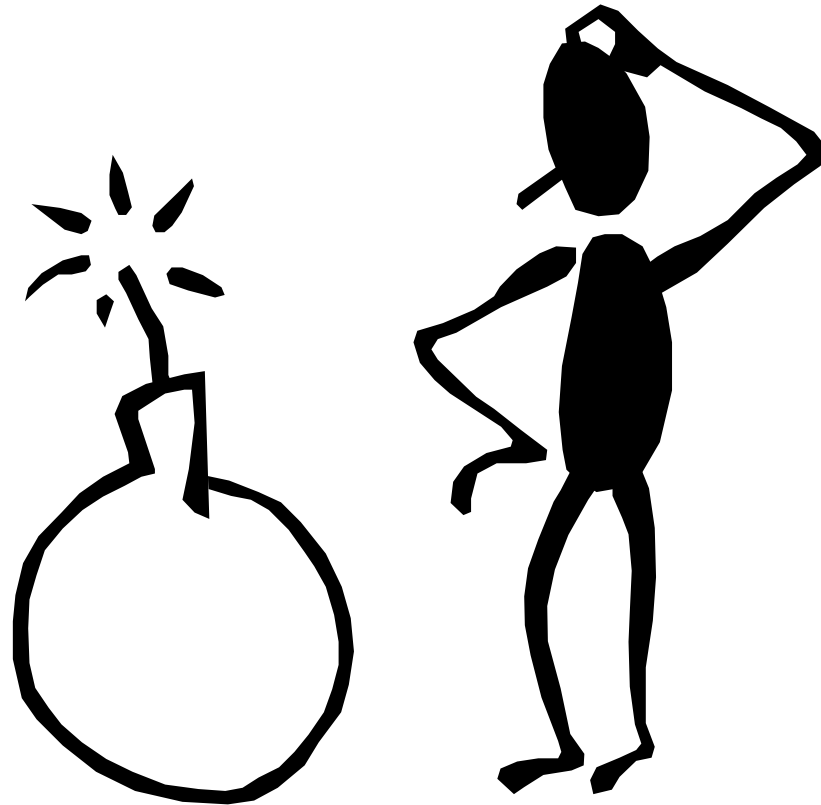
# Human Factors Model



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# ARE THERE ANY QUESTIONS?



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