Construction Management and Project Engineering

Changbum R. Ahn, PhD
Email : cbahn@snu.ac.kr

SEOUL NATIONAL UNIVERSITY

Recap

- Fall, Struck-by, and Ergonomic Hazard

- 건설안전특별법

Case Study: Safety Management Practices

- Examine and report current practices of safety management
  - Site visit & Interview
  - Report (20 min/team)
    - ✓Project overview & current progress
    - ✓Safety team organization (including sub, outsourcing)
    - ✓Role and activities of safety team members
    - ✓Major hazards and prevention strategy
    - ✓Management issues
    - ✓Violations, near-misses, and accidents

Unit 4. Safety Management

Safety Management

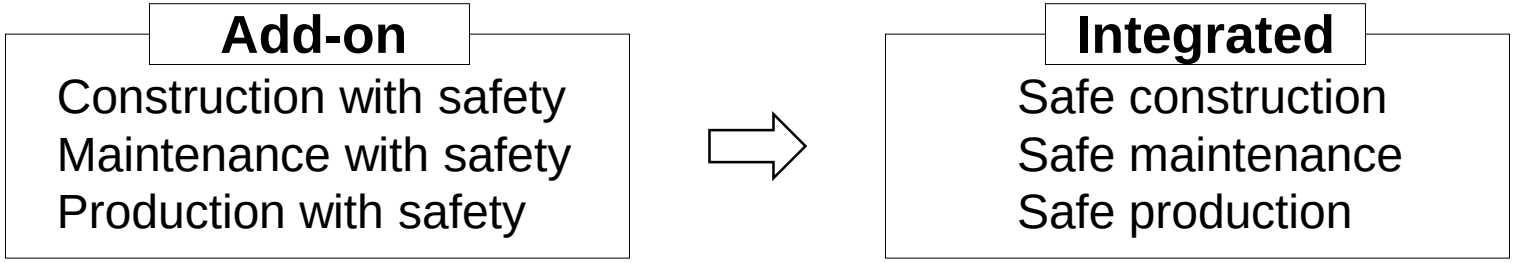
- Traditional Approach
  - Safety Department is responsible for safety
  - Safety Programs
    - ✓Inspection
    - ✓Accident investigation
    - ✓Employee training
    - ✓Supervisor as “key man”
    - ✓Recordkeeping
    - ✓Behavior modification (e.g., incentives, posters)

Safety Management

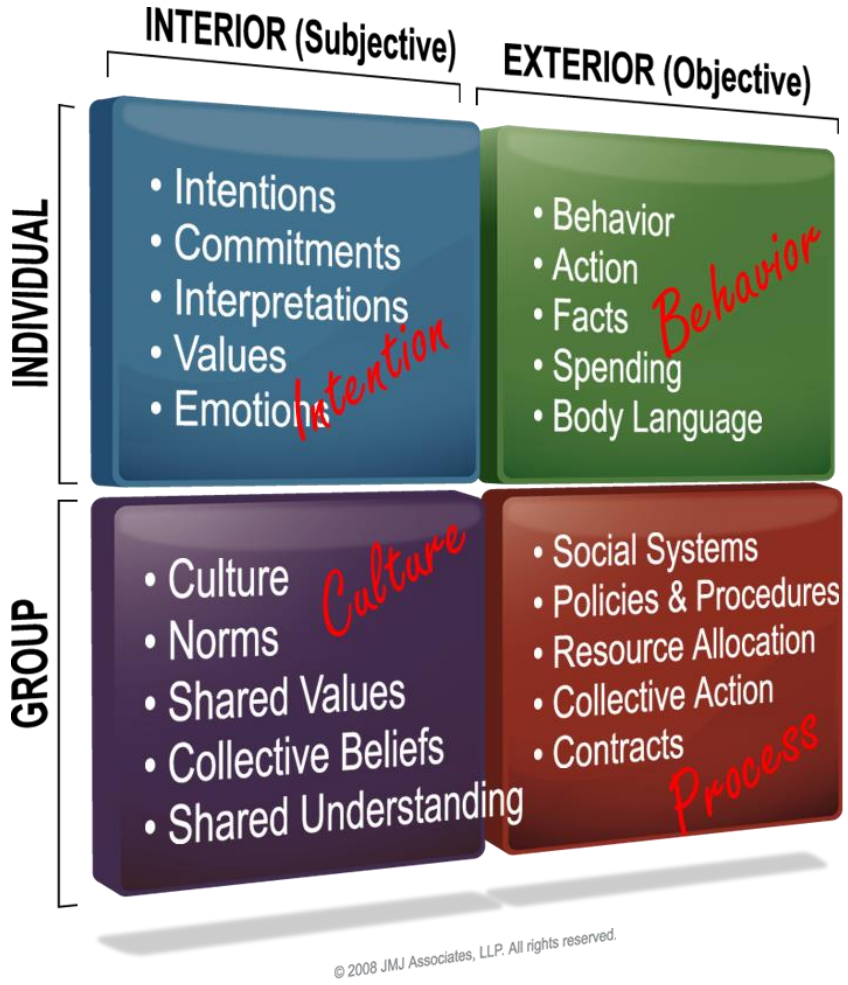
- Advanced Approach to Accident Investigation
  - “Employees cuts finger with hand grinder”
  - Proximal Causes (Sharp End - near scene)
    - ✓Employee was using grinder without guard
    - ✓Employee awareness deficiency
    - ✓Employee not wearing gloves
  - Distal Causes (Blunt End - away from scene)
    - ✓Tool purchased without guard (Purchasing)
    - ✓Employee qualifications misrepresented (Personnel)
    - ✓Employee working 16 hours day of incident (Scheduling)
    - ✓No resources budgeted for gloves or tool guarding (Budget)

Safety Management

- New paradigm of Safety Management
  - “Look at Culture”
  - Effective safety management
    - ✓Having employee participation
    - ✓Emphasizing supervisory performance
    - ✓Involving middle management
    - ✓Top management visually shows their commitment
    - ✓Being flexible and perceived as positive



An Integral Approach to Safety



* *The Integral Model is based on the work of Ken Wilber*

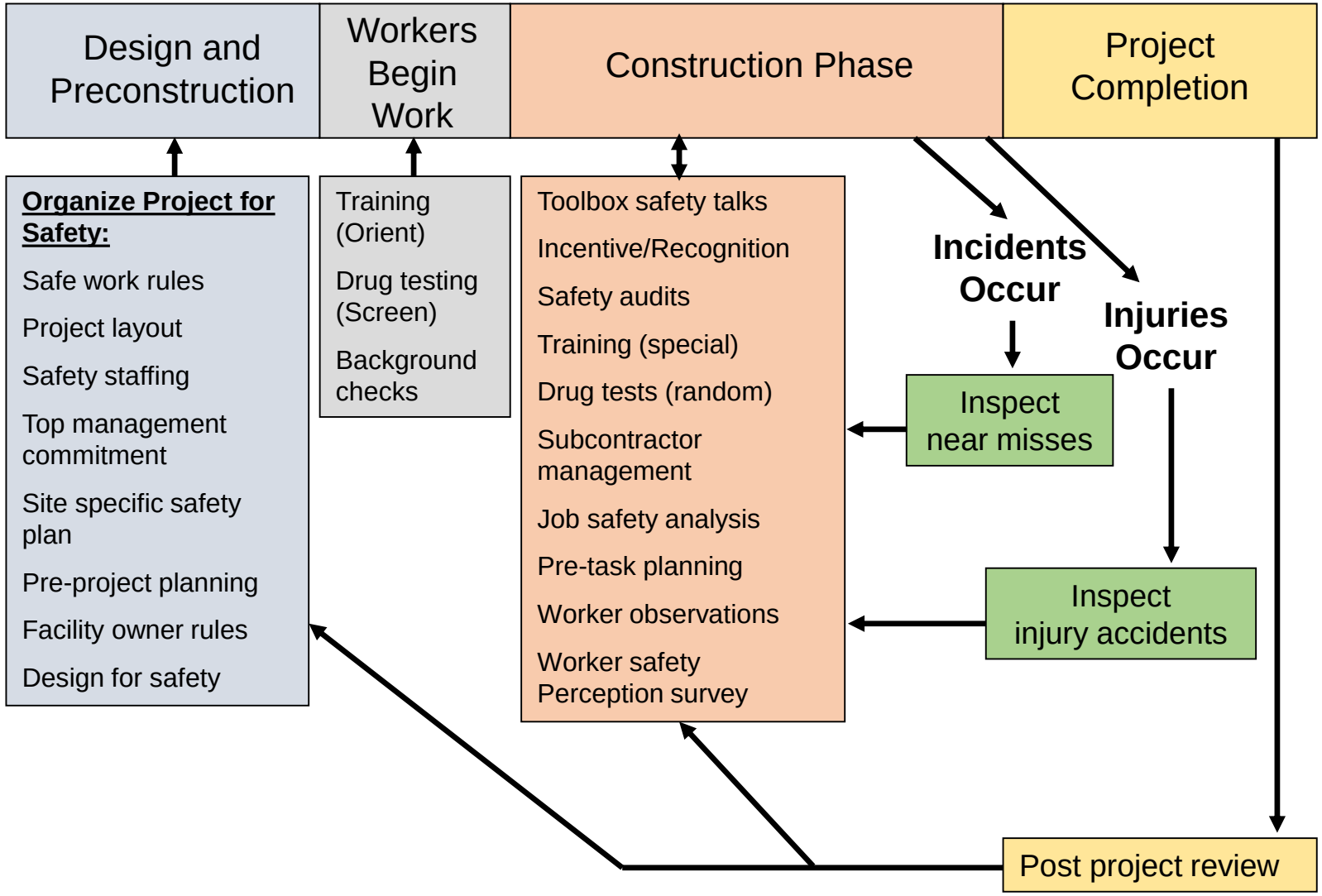
- A more complete view of reality.
- Allows study of what drives performance.
- Highlights the importance of the human side of safety leadership.
- The desired change is in behavior and the attitudes and intentions that direct that behavior.
- Organizations tend to implement change through Process

Principles of Safety Management

- An unsafe act, an unsafe condition, and an accident are all symptoms of something wrong in the management system.
- We can predict that certain sets of circumstances will produce severe injuries.
- Safety should be managed like any other company function.
- The key to effective line safety performance is management procedures that fix accountability (individual roles plus everyone's responsibility for safety).
- The function of safety is to locate and define the operational errors that allow accidents to occur.
- The causes of unsafe behavior can be identified and classified.
- In most cases, unsafe behavior is normal human behavior; it is the result of normal people reacting to their environment.
- There are three major subsystems that must be dealt with in building an effective safety system: (1) the physical, (2) the managerial, and (3) the behavioral.
- The safety system should fit the culture of the organization.
- There is no one right way to achieve safety in an organization; however, for a safety system to be effective, it must meet certain criteria (e.g., participation, involvement).

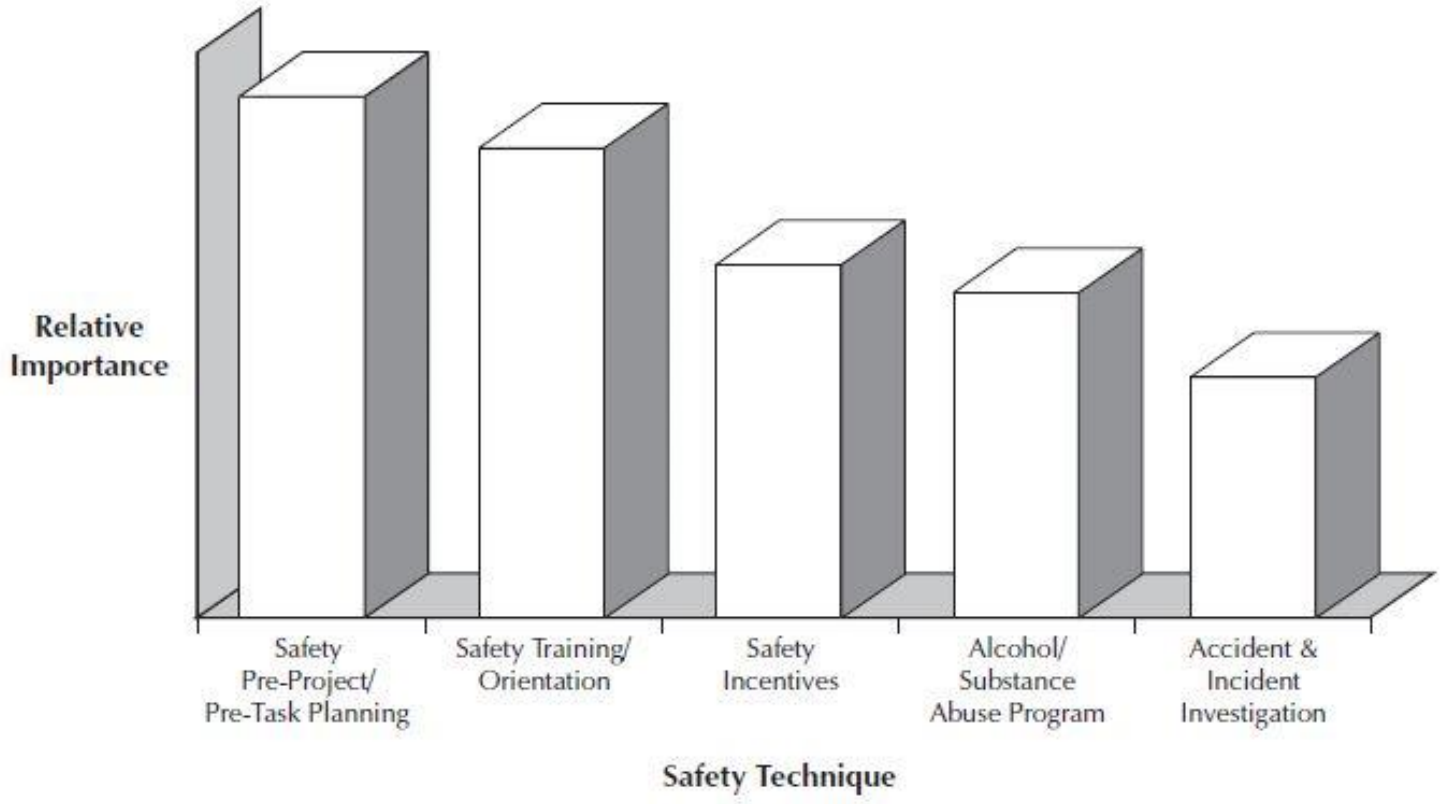
[Dan Petersen 1989. Techniques of Safety Management: A System Approach, 3rd ed.]

Safety Management Programs



Safety Programs and Techniques

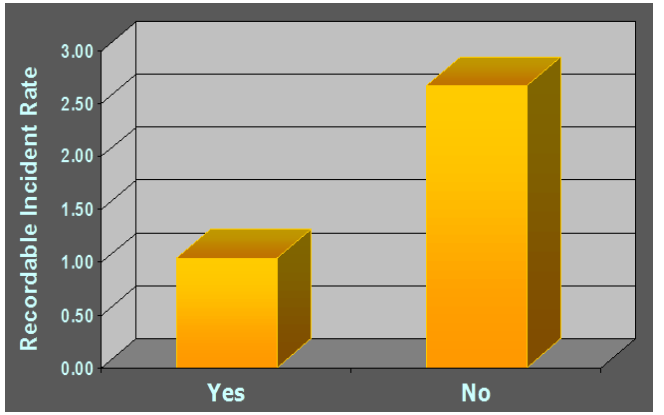
- Five highly impact safety techniques:
  Construction Industry Institute (CII) recommendation



Safety Programs and Techniques

- Safety Pre-Project/Pre-Task Planning
  - Pre-Project
    - ✓ Safety goals
    - ✓ Safety person/personnel
    - ✓ Pre-placement employee evaluation
  - Pre-Task
    - ✓ Task hazard analysis
    - ✓ Task training

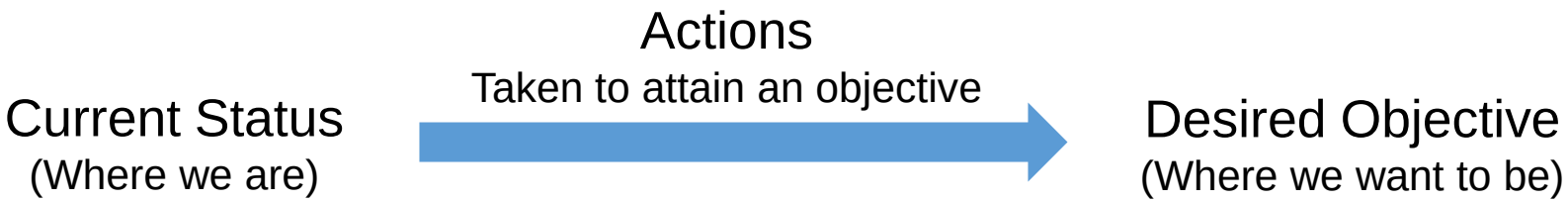
Pre-task planning meeting held?



- Regulation Example (OHS Code 2009, Alberta)
  - Hazard Assessment
    - ✓ "7(1) An employer must assess a work site and identify existing and potential hazards before work begins at the work site or prior to the construction of a new work site.
    - ✓ 7(2) An employer must prepare a report of the results of a hazard assessment and the methods used to control or eliminate the hazards identified."

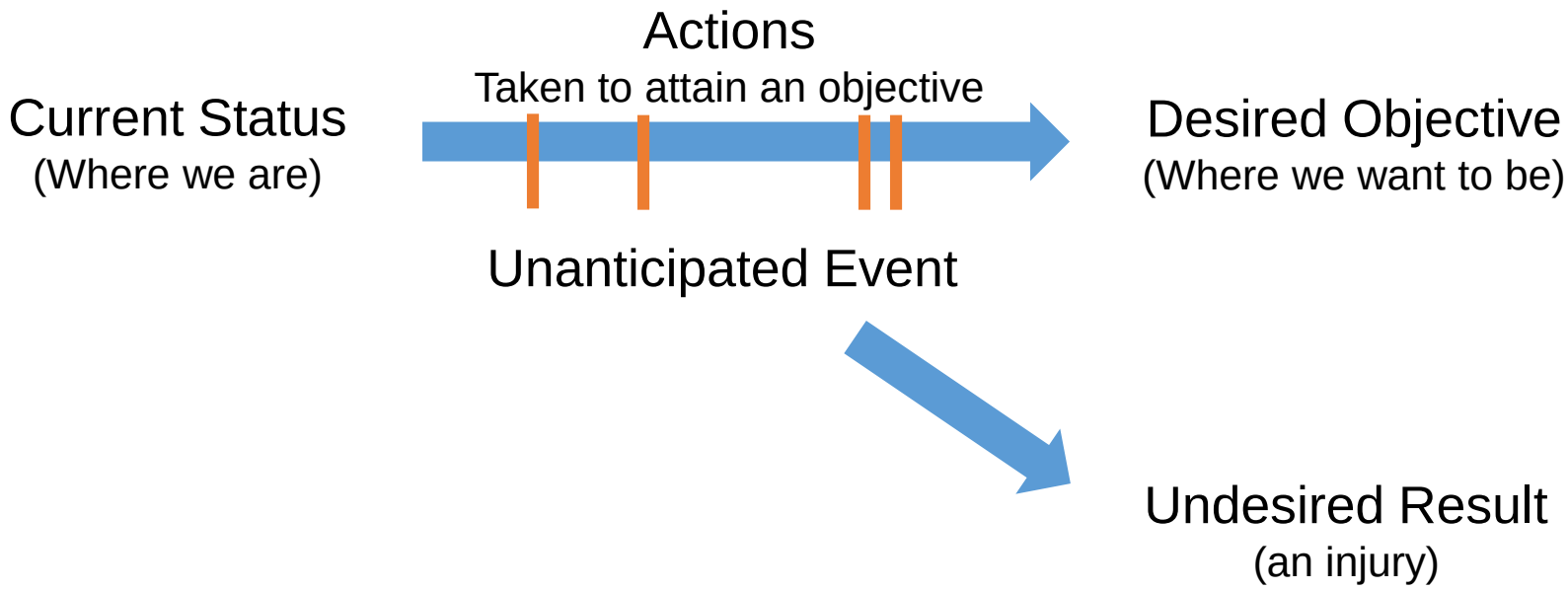
Safety Programs and Techniques: Safety Pre-Project/Pre-Task Planning

- Jobsite Safety Assessment
  - "An ideal world" → Goal Attainment with no RISK



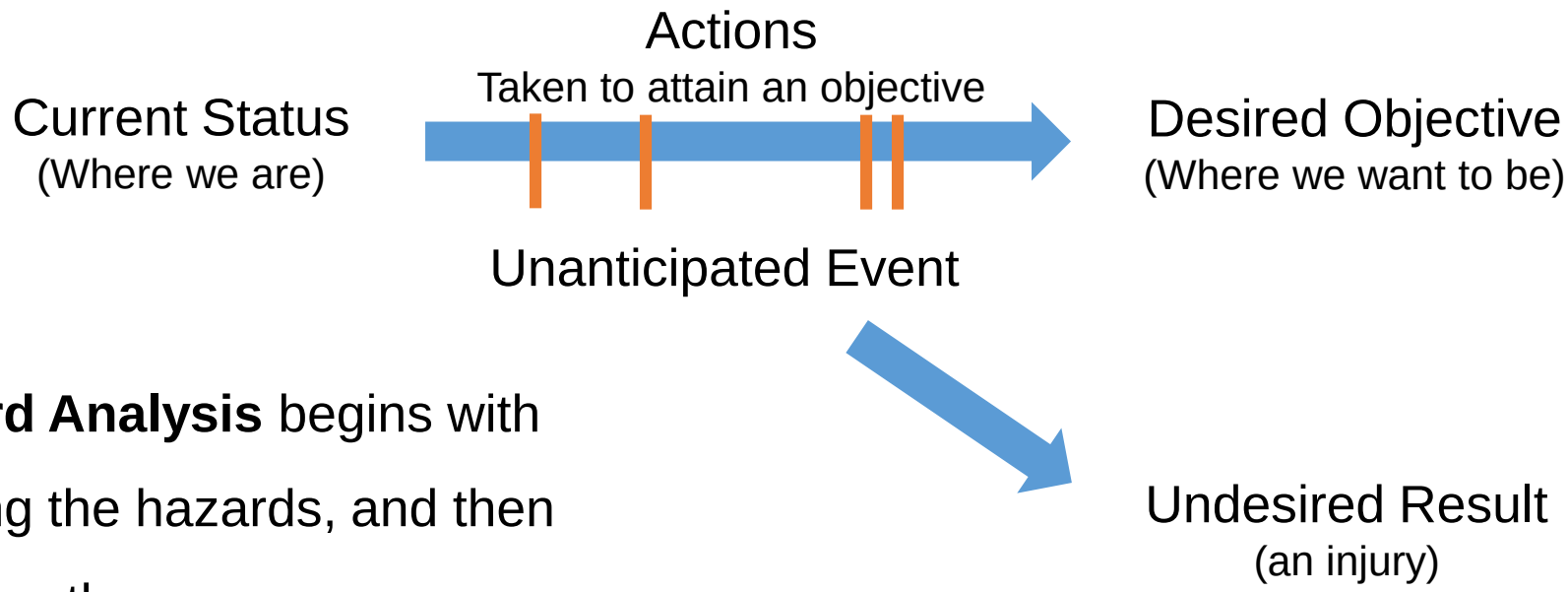
Safety Programs and Techniques: Safety Pre-Project/Pre-Task Planning

- Jobsite Safety Assessment
  - "An real world" →There are obstacles – RISK



Safety Programs and Techniques: Safety Pre-Project/Pre-Task Planning

- Jobsite Safety Assessment
  - "An real world" →There are obstacles – RISK



➔ **Job Hazard Analysis** begins with

- Identifying the hazards, and then
- Eliminating them.

Safety Programs and Techniques: Safety Pre-Project/Pre-Task Planning

- Jobsite Safety Assessment
  - Objectives
    - ✓ Identify and understand the nature of all major safety and health hazards on the project.
    - ✓ By identifying hazards early, it is possible to control and mitigate their impact.
  - Different times and types of assessment
    - ✓ Before construction begins (project level)
    - ✓ During construction (project level)
    - ✓ During construction (crew level): Pre-Task
  - Procedures
    - ✓ Identification → Evaluation → Control/Mitigation

Safety Programs and Techniques: Safety Pre-Project/Pre-Task Planning

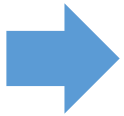
- Pre-Project / Pre-Construction Jobsite Assessment
  - Identification
    - ✓ Consider the various types of hazards
    - ✓ Tasks to be performed (schedule)
    - ✓ Materials to be used (technical specifications)
    - ✓ Equipment to be employed (schedule)
    - ✓ Hazardous conditions (plans)
    - ✓ Site hazards (job walk-through)
  - Consider non-routine work tasks
    - ✓ Start-up activities, cleaning, testing, shutdown procedures, and tear-outs and demolition.
  - Consider who will be at risk
    - ✓ Workers, environment (e.g., air, water, land), facility, product or service, equipment, and public.

Safety Programs and Techniques: Safety Pre-Project/Pre-Task Planning

- Pre-Project / Pre-Construction Jobsite Assessment
  - Evaluation
    - ✓Define the physical agent that is hazardous
    - ✓Define the harm that can be caused
    - ✓Define the likelihood of harm occurring
    - ✓Risk = Severity of adverse effect x probability of occurrence
  - Control and Mitigation
    - ✓Devise means to reduce the unacceptable risk
      - Engineering controls, administrative controls, specific work procedures, PPE, and environmental controls.
    - ✓Re-evaluate the risk: Is the risk acceptable with the controls?

Safety Programs and Techniques: Job Hazard Analysis

- Pre-Task Planning: Job Hazard Analysis
  - Procedure is similar to pre-project jobsite assessment
  - Focus is on an individual task
  - Processes
    - ✓ Identify sources of danger
    - ✓ Define the risk
    - ✓ Devise control measure
    - ✓ Fully inform all parties involved
    - ✓ Document the steps taken
  - Types of assessment
    - ✓ Unsafe physical conditions
    - ✓ Unsafe worker behavior



What can go wrong?
What are the consequences?
How likely is it that the hazard will occur?
How could it arise?
What are other contributing factors?

Safety Programs and Techniques: Job Hazard Analysis

➢ Pre-Task Planning: Job Hazard Analysis

- Controlling the hazards

  ✓ **Engineering Controls**: The most effective controls are engineering controls that physically change a machine or work environment to prevent employee exposure to the hazard.

  ✓ **Administrative Controls**: If this is not feasible, administrative controls may be appropriate. This may involve changing how employees do their jobs.

  ✓ **Personal Protective Equipment (PPE):** When engineering controls are not feasible or do not totally eliminate the hazard; when safe work practices do not provide sufficient additional protection.

Safety Programs and Techniques: Job Hazard Analysis

➢ Pre-Task Planning: Job Hazard Analysis

- Analysis Procedures
  - ✓Select the job task to be analyzed
  - ✓Identify the major sequence of steps for each sub-task (job description)
  - ✓Identify the potential hazards for each step (hazard identification)
  - ✓Determine preventative measures to protect against the hazards (hazard controls)
  - ✓Develop a worker-training program
  - ✓Re-evaluation

Safety Programs and Techniques: Job Hazard Analysis

- Exercise: Grinding iron casting

- Job steps
  - Step 1: Reach into metal box to right of machine, grasp casting, and carry to wheel.
  - Step 2: Push casting against wheel to grind off burr.
  - Step 3: Place finished casting in box to left of machine.

Safety Programs and Techniques: Job Hazard Analysis

- Exercise: Grinding iron casting

Sequence of Events	Potential Accidents or Hazards	Preventive Measures
1. Reach into box to the right of the machine, gras p casting and carry to wheel.		
2. Push casting against wheel to grind off burr.		
3.Place finished casting in box to the left of the mach ine.		

Safety Programs and Techniques: Job Hazard Analysis

- Exercise: Grinding iron casting

Sequence of Events	Potential Accidents or Hazards	Preventive Measures
1. Reach into box to the right of the machine, grasp casting and carry to wheel.	Strike hand on edge of metal box or casting; cut hand on burr; drop casting on toes.	
2. Push casting against wheel to grind off burr.	Strike hand against wheel; sparks in eyes; wheel breakage; dust; sleeves get caught.	
3.Place finished casting in box to the left of the machine.	Strike hand against metal box or casting.	

Safety Programs and Techniques: Job Hazard Analysis

- Exercise: Grinding iron casting

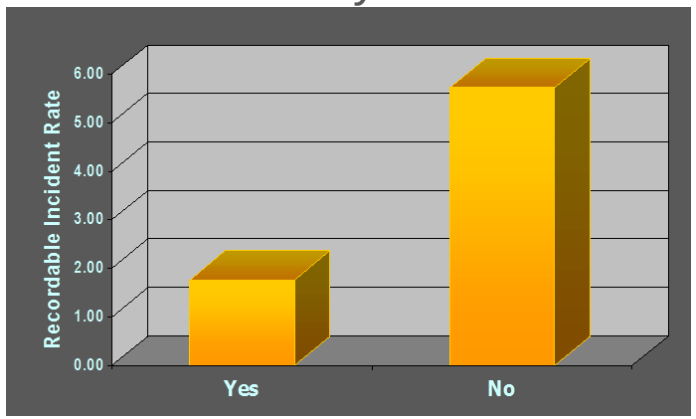
Sequence of Events	Potential Accidents or Hazards	Preventive Measures
1. Reach into box to the right of the machine, grasp casting and carry to wheel.	Strike hand on edge of metal box or casting; cut hand on burr; drop casting on toes.	Provide gloves and safety shoes.
2. Push casting against wheel to grind off burr.	Strike hand against wheel; sparks in eyes; wheel breakage; dust; sleeves get caught.	Provide larger guard over wheel. Provide safety goggles. Instruct employee to wear short sleeved shirts.
3.Place finished casting in box to the left of the machine.	Strike hand against metal box or casting.	Provide tool for removal of completed stock.

Safety Programs and Techniques

- Safety Orientation and Training
  - Site orientation
  - Owner involved in orientation
  - Safety policies and procedures
  - Project specific orientation
  - Formal safety training

- Regulation Example (Canada OHS)
  - Employee Education

Every worker on site receive safety orientation?



“19.6 (1) The employer shall provide health and safety education, including education relating to ergonomics, to each employee which shall include the following:
(a) the hazard prevention program implemented in accordance with this Part to prevent hazards applicable to the employee, including the hazard identification and assessment methodology and the preventive measures taken by the employer;
…”

Safety Programs and Techniques: Safety Orientation and Training

- Objective of safety meetings
  - Educate workers
  - Motivate workers
  - Change workers' behavior

- When to hold safety meetings
  - Commonly held on Mondays
  - Consider alternating the timing
  - Before major changes in the work (possibly more frequently than weekly)

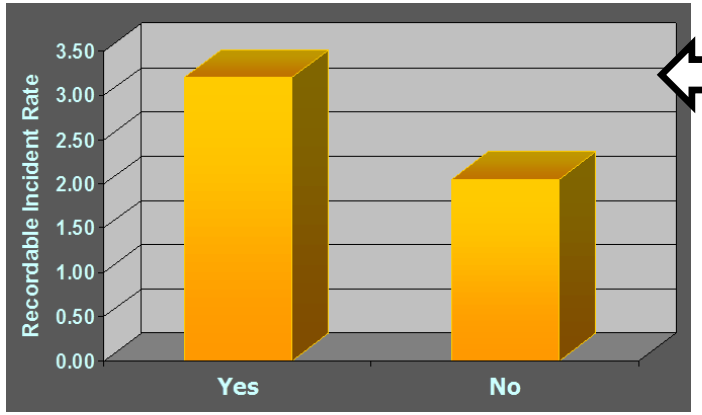
- What topics to discuss
  - Training materials
  - Project specific topics
  - Up-coming work schedule and a new piece of equipment
  - Safety violations noted
  - Accidents and near misses

Safety Programs and Techniques

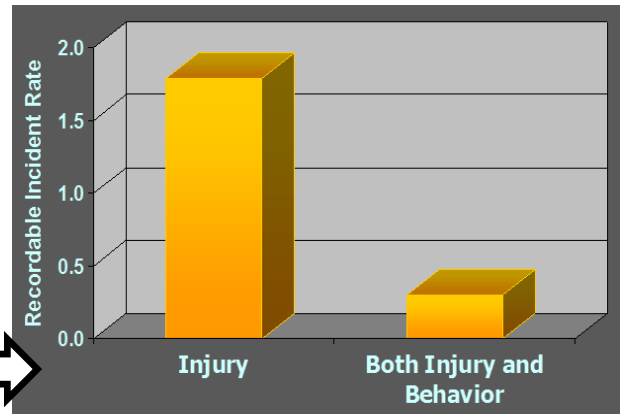
- Written Safety Incentive Program
  - Cents per hour for workers
  - Spot cash incentives used with workers
  - Milestone cash incentives given to workers
  - End of project incentives given to workers

Research: The effectiveness has not been confirmed, but the way to implement it is a key to its success.

The project have a formal worker incentive program?
➔ Found to be not statistically significant.



Incentives are based on injury occurrence or both behavior and injury occurrence?

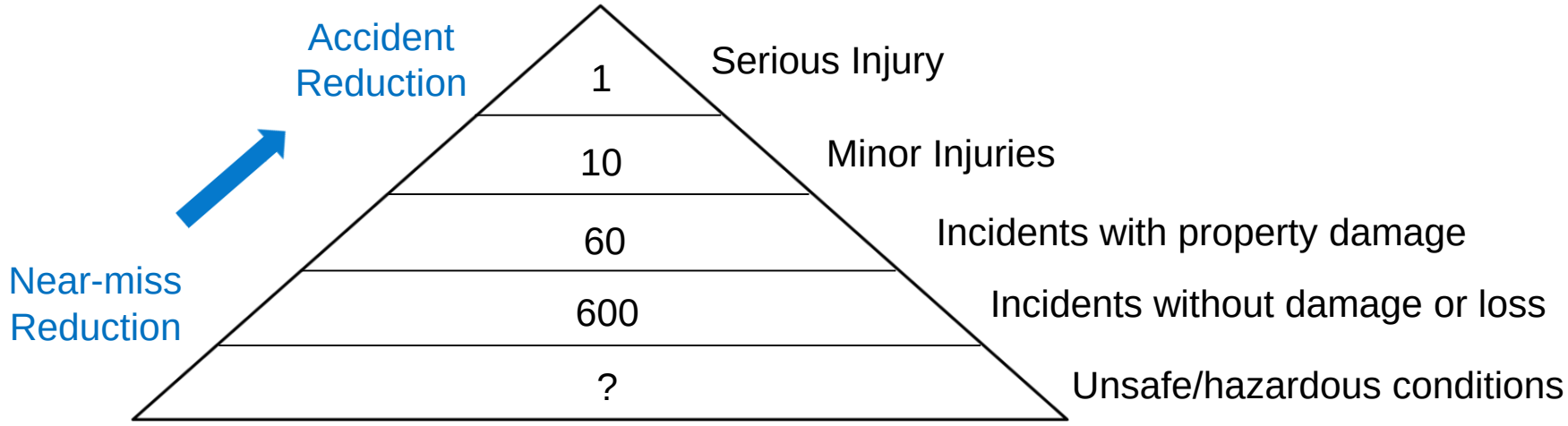


Safety Programs and Techniques: Safety Incentive Program

- Objective of incentive programs
  - Reinforcing good or safe behavior
  - Altering poor or unsafe behavior
- Who is to be motivated by the incentives?
  - Workers
  - Crew members
  - Supervisors
  - Project managers
  - Safety personnel

Safety Programs and Techniques: Safety Incentive Program

- Type of work to be rewarded:
  - Number of lost time injuries? Rare events
  - Number of first aid injuries? Can be frequent events – watch for non-reporting
  - Number of near misses noted? Will be noticed if recorded
  - Safe work behavior

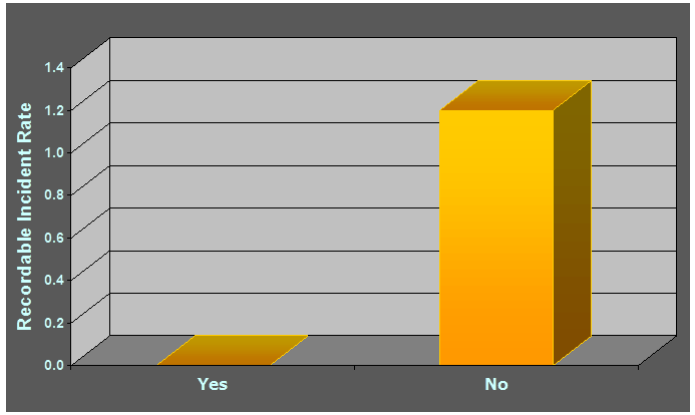


[Near-miss incident theory (Phimister et al. 2003; Bird and Germain 1996)]

Safety Programs and Techniques

- Alcohol and Substance Abuse Program (ASAP)
  - Screening done for alcohol and drugs
    - ✓ Alcohol (legal), marijuana, heroin, cocaine, crack cocaine, LSD, over-the-counter drugs, prescription drugs
  - Screening can be conducted at random
  - Post accident screening can be done for all employees

Drug testing conducted?

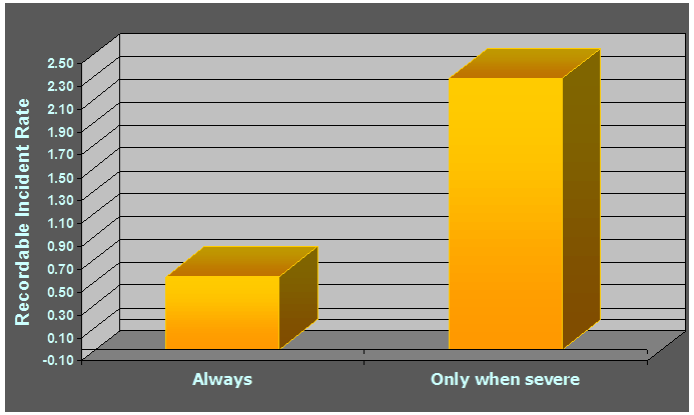


[CII 1993, Zero Injury Techniques]

Safety Programs and Techniques

- Accident/Incidents Investigations
  - Accidents investigated
  - Incidents reported to home office
  - Incidents without injury investigated
  - Project accident review team established for all accidents or incidents
  - Project work exposure hours and safety statistics reported to home office.

When are near misses investigated?

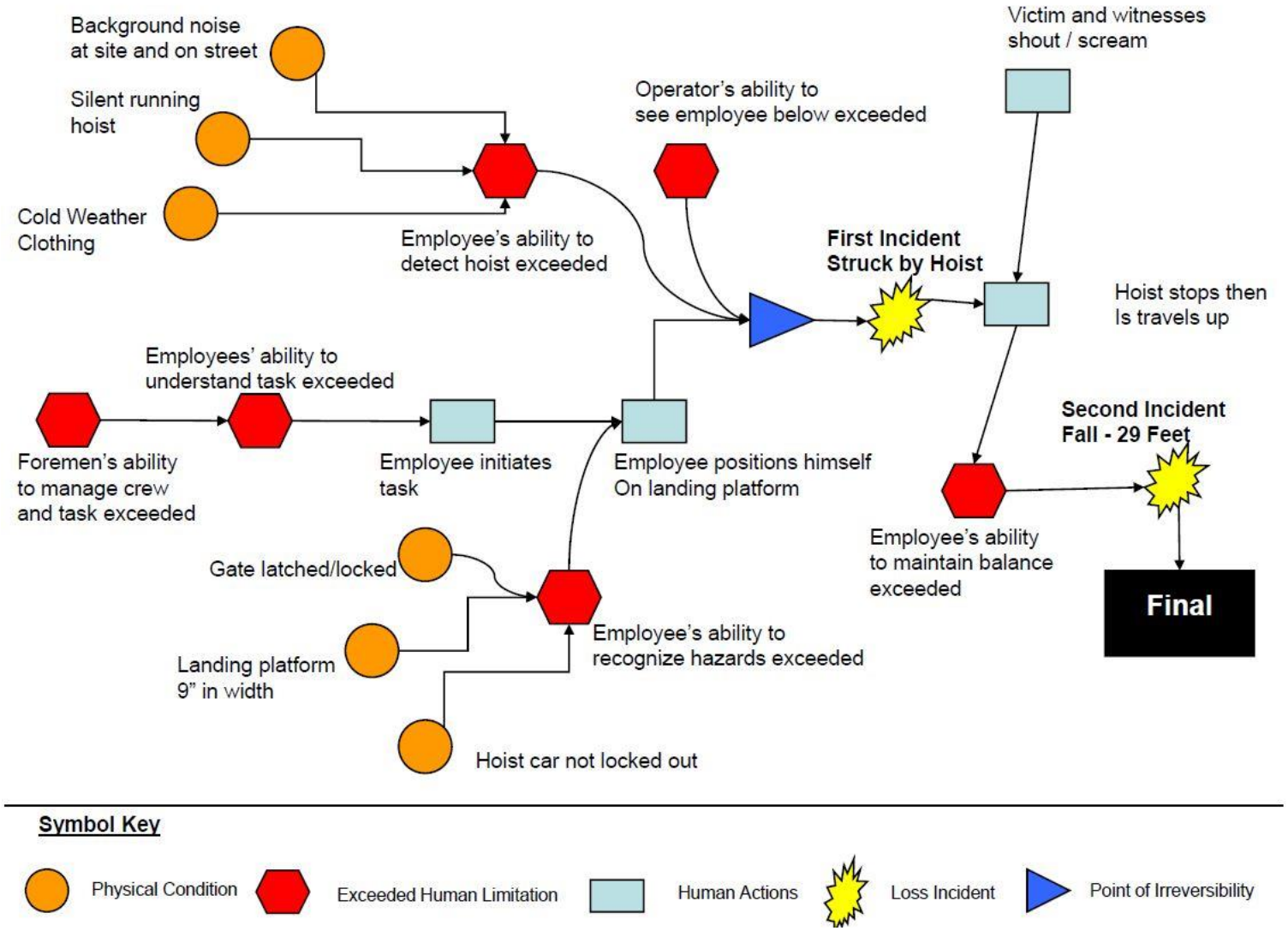


[CII 1993, Zero Injury Techniques]

Safety Programs and Techniques: Accident/Incident Investigation

- Accident Investigation
  - Detailed analysis of what happened
  - Fact finding, not fault finding
  - Identify root causes to avoid further occurrences
  - Communication of findings
- Universal Model
  - Use to analyze results of investigation
  - Proximal causes – close to incident
  - Distal causes – distant from incident
  - Use a diagram to establish sequence of events
  - Leads to “root causes”

Universal Model Diagram: Example

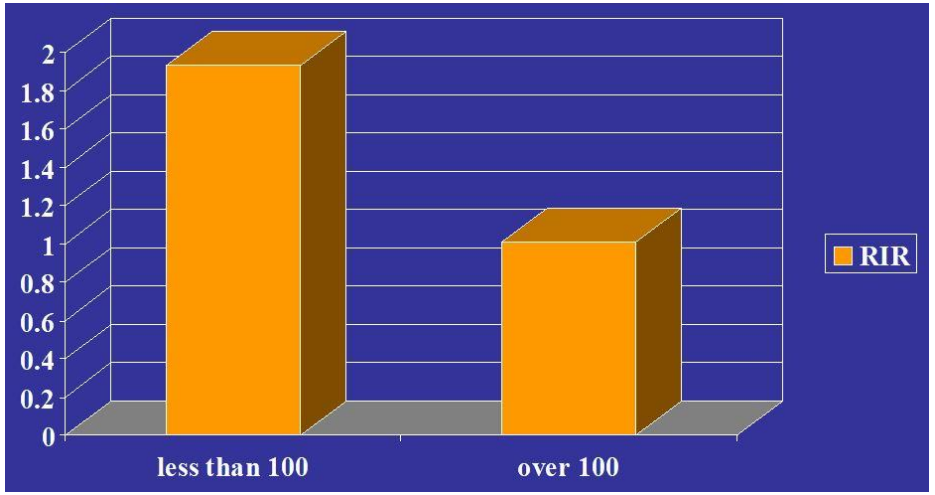


Five Ys Technique

Proximal Causal Factor From Model	Why?	Why?	Why?	Why?	5th Why?
 Foremen's ability to manage crew and task exceeded	Foremen did not follow pre-task plan as agreed one week prior	Management did not walk foremen through plan day of incident	Manager assigned task oversight to less experienced staff member	Project team staffed with less experienced staff	Company experiencing high work volume and availability of experience staff scarce.
 Employee's ability to understand task exceeded	Foremen did not follow plan. Specifically brief crew prior to execution	Pre-task planning and briefings not in writing.	Management has not fully implemented pre-task planning as a basic requirement. Developed ad hoc.	Corporate has not fully developed or embedded a pre-task planning process as part of the systems	Corporate Safety procedure update long overdue. No dedicated staff assigned to develop, upgrade and maintain program.
 Employees' ability to recognize hazards exceeded	Employee did not attend New Hire Safety Orientation Program	Employee's foremen did not insist on employee attending orientation	Subcontractor did not adequately communicate policy to 3rd Tier subcontractor	Management team did not implement program to address all workers prior to work on site	Project teams struggle with implementing an effective orientation program
 Hoist cars not locked out	Pre-task plan references "locking out" hoist, not executed.	No formal Lock-out program submitted by subcontractor	Project team did not anticipate the need for a lockout procedure for subcontractor	Pre-con risk assessment not completed to this level of detail	Pre-con risk assessment relies too heavily on PM knowledge of hazards

Safety Programs and Techniques

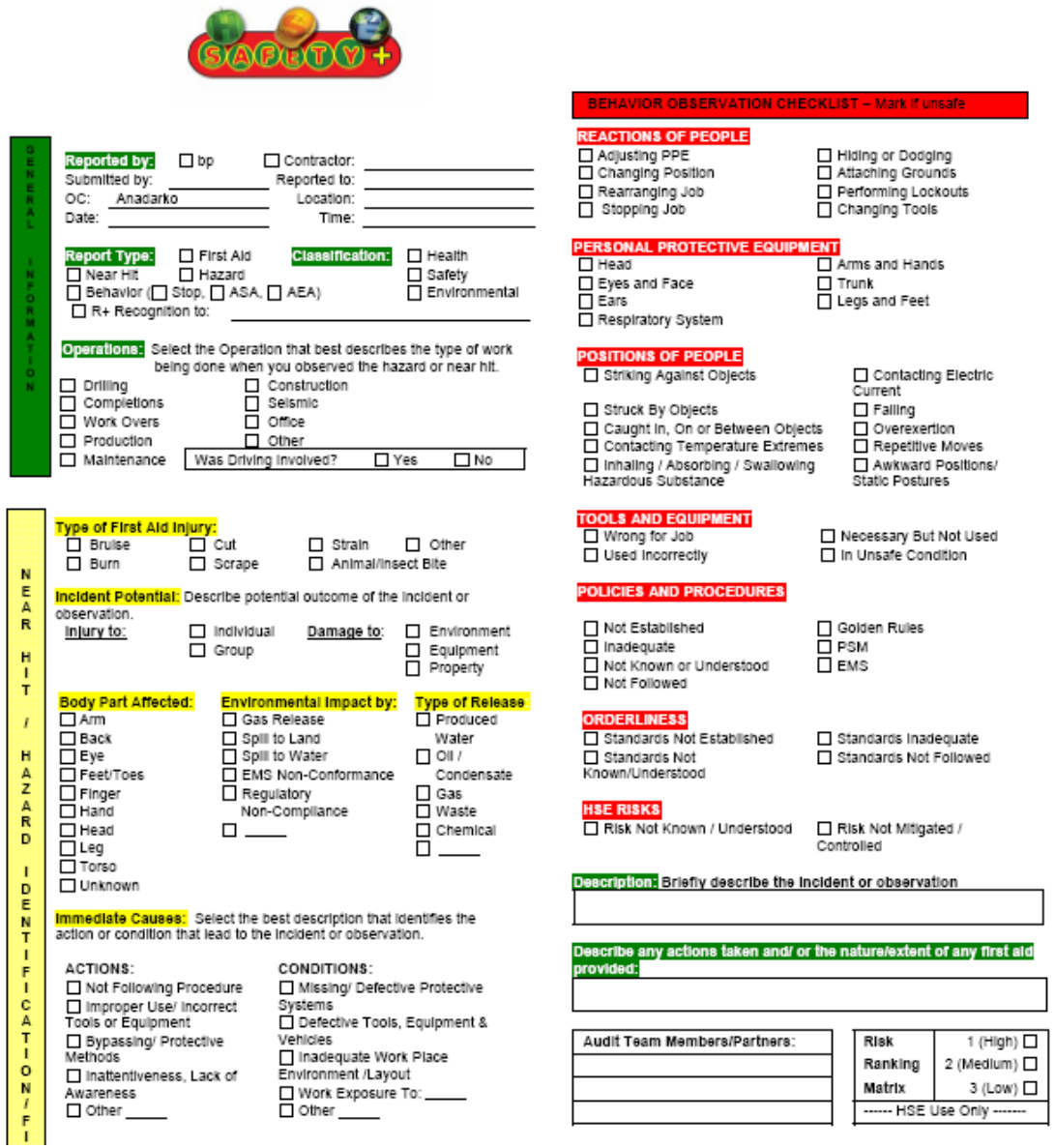
- Worker Observation
  - Document unsafe behavior
  - Worker involvement in the process: Peer to peer method of coaching, counseling, and encouraging all employees to reinforce safety behavior
  - Conduct trend analysis
  - No name and no blame



What is the number of observations recorded?

Safety Programs and Techniques: Worker Observation

- Example of Observation Card
  - This card can also be used for near miss, first aid, or any hazard identification.
  - This kind of data can easily be collected, and the trend can be analyzed to identify the cause and appropriate actions for the prevention.



GENERAL INFORMATION

Reported by: ☐ bp ☐ Contractor: _____
Submitted by: _____ Reported to: _____
OC: Anadarko Location: _____
Date: _____ Time: _____

Report Type: ☐ First Aid **Classification:** ☐ Health
☐ Near Hit ☐ Hazard ☐ Safety
☐ Behavior (☐ Stop, ☐ ASA, ☐ AEA) ☐ Environmental
☐ R+ Recognition to: _____

Operations: Select the Operation that best describes the type of work being done when you observed the hazard or near hit.

☐ Drilling ☐ Construction
☐ Completions ☐ Seismic
☐ Work Overs ☐ Office
☐ Production ☐ Other
☐ Maintenance Was Driving Involved? ☐ Yes ☐ No

NEAR HIT / HAZARD IDENTIFICATION / FI

Type of First Aid Injury:
☐ Bruise ☐ Cut ☐ Strain ☐ Other
☐ Burn ☐ Scrape ☐ Animal/Insect Bite

Incident Potential: Describe potential outcome of the incident or observation.
Injury to: ☐ Individual ☐ Group
Damage to: ☐ Environment ☐ Equipment ☐ Property

Body Part Affected:
☐ Arm ☐ Back ☐ Eye ☐ Feet/Toes ☐ Finger ☐ Hand ☐ Head ☐ Leg ☐ Torso ☐ Unknown

Environmental Impact by:
☐ Gas Release ☐ Spill to Land ☐ Spill to Water ☐ EMS Non-Conformance ☐ Regulatory Non-Compliance ☐ ____

Type of Release
☐ Produced Water ☐ Oil / Condensate ☐ Gas ☐ Waste ☐ Chemical ☐ ____

Immediate Causes: Select the best description that identifies the action or condition that lead to the incident or observation.

ACTIONS:
☐ Not Following Procedure
☐ Improper Use/ Incorrect Tools or Equipment
☐ Bypassing/ Protective Methods
☐ Inattentiveness, Lack of Awareness
☐ Other ____

CONDITIONS:
☐ Missing/ Defective Protective Systems
☐ Defective Tools, Equipment & Vehicles
☐ Inadequate Work Place Environment /Layout
☐ Work Exposure To: ____
☐ Other ____

BEHAVIOR OBSERVATION CHECKLIST – Mark if unsafe

REACTIONS OF PEOPLE
☐ Adjusting PPE ☐ Hiding or Dodging
☐ Changing Position ☐ Attaching Grounds
☐ Rearranging Job ☐ Performing Lockouts
☐ Stopping Job ☐ Changing Tools

PERSONAL PROTECTIVE EQUIPMENT
☐ Head ☐ Arms and Hands
☐ Eyes and Face ☐ Trunk
☐ Ears ☐ Legs and Feet
☐ Respiratory System

POSITIONS OF PEOPLE
☐ Striking Against Objects ☐ Contacting Electric Current
☐ Struck By Objects ☐ Falling
☐ Caught In, On or Between Objects ☐ Overexertion
☐ Contacting Temperature Extremes ☐ Repetitive Moves
☐ Inhaling / Absorbing / Swallowing Hazardous Substance ☐ Awkward Positions/ Static Postures

TOOLS AND EQUIPMENT
☐ Wrong for Job ☐ Necessary But Not Used
☐ Used Incorrectly ☐ In Unsafe Condition

POLICIES AND PROCEDURES
☐ Not Established ☐ Golden Rules
☐ Inadequate ☐ PSM
☐ Not Known or Understood ☐ EMS
☐ Not Followed

ORDERLINESS
☐ Standards Not Established ☐ Standards Inadequate
☐ Standards Not Known/Understood ☐ Standards Not Followed

HSE RISKS
☐ Risk Not Known / Understood ☐ Risk Not Mitigated / Controlled

Description: Briefly describe the incident or observation

Describe any actions taken and/ or the nature/extent of any first aid provided:

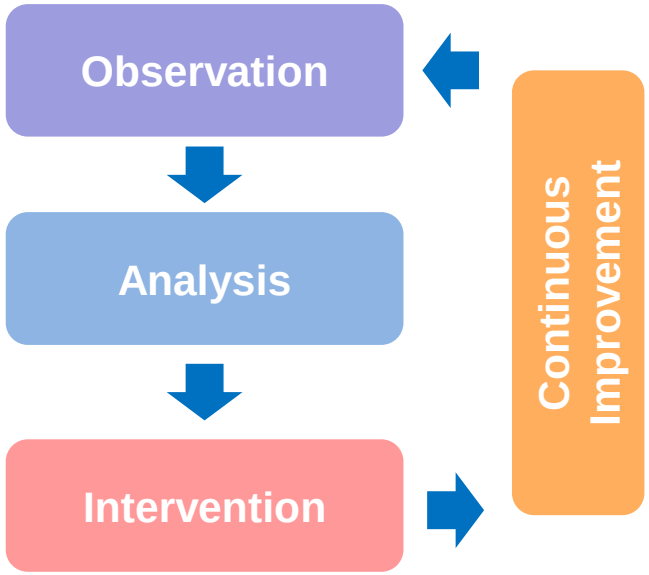
Audit Team Members/Partners:

Risk Ranking Matrix	1 (High) ☐
	2 (Medium) ☐
	3 (Low) ☐
------ HSE Use Only -------	

Safety Programs and Techniques: Worker Observation

➢ Motivation

- Unsafe acts and behavior of workers → 80~90% of accidents
  (Heinrich et al. 1980; Salminen and Tallberg 1996; Helen and Rowlinson 2005)
- Management Procedures: Behavior-based Safety



- Observe people including yourself.
- Analyze their work practice by focusing on safe and unsafe behaviors.
- Talk with them about safety.
- Actively correct and prevent unsafe acts and conditions.
- Reinforce safe behavior.
- Report your observations.

Safety Programs and Techniques: Worker Observation

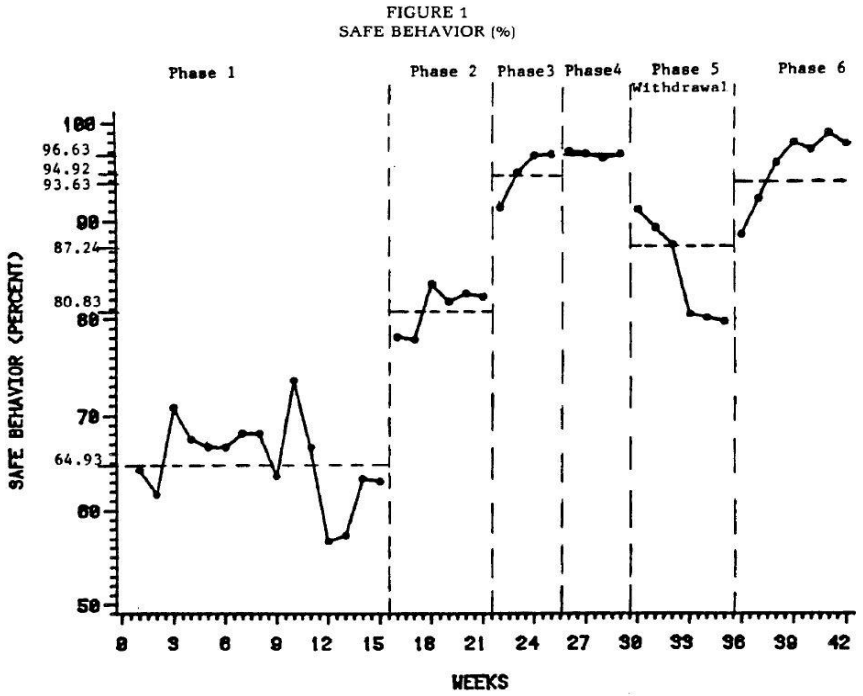
- Basics of Behavior-based Safety Management
  - Develop a simple, written company-specific program appropriate for your company.
  - #1 message is “all employee have the obligation to stop work that is unsafe.”
  - Train employees and subcontractors in the program and document the training.
  - Gather and trend data on a regular basis.
  - Use the data to understand types of at-risk behaviors, develop performance targets, and address behavior targeted for improvement.
  - Use trend data to develop action plans and improve the training.
  - Share observations, trend data, and performance target with employees.

Safety Programs and Techniques: Worker Observation

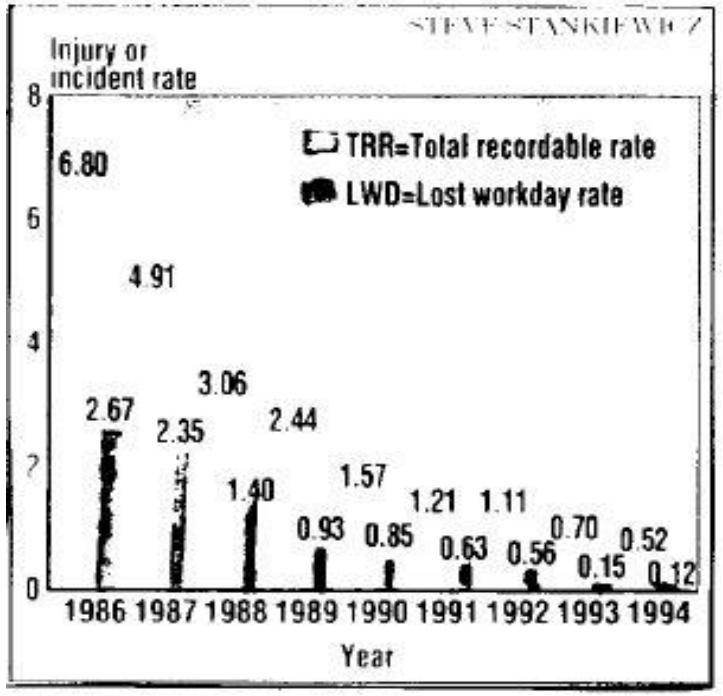
- Keys for Successful Implementations
  - The name of the person being stopped should not be included (or blamed) except for positive recognition.
  - The proper response to being stopped is “Thank you.”
  - Observation should be kept positive, not a “Penalty.”
  - Incentives work well for building an in-depth safety program. Examples include best observation, most quality observations, etc.
  - “What happened and what did you do about it” is a simple criteria for a quality observation.
  - Once the written program is in place, build on it as appropriate in the spirit of continual improvement.

Safety Programs and Techniques: Worker Observation

- Case Studies: Program Implementations
  - Significant improvement of safety performances
  - (Godbey 2006; Villane 1995; Duff et al. 1994; Krause et al. 1999; Komaki et al. 1978)



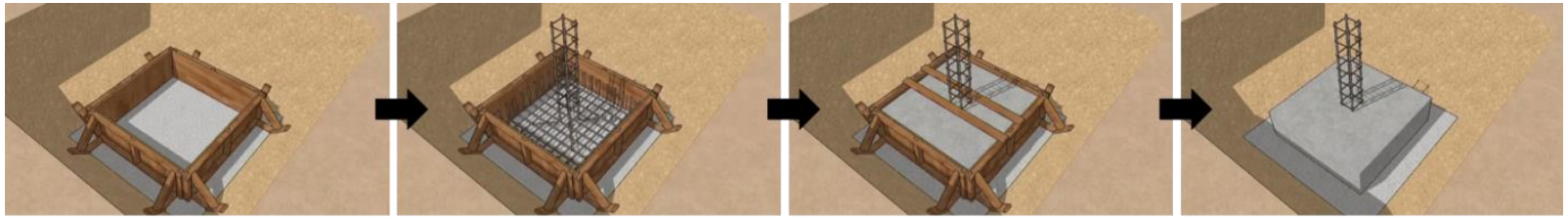
Chhokar, J. S. and Wallin, J. A. (1984). Improving Safety through Applied Behavior Analysis. Journal of Safety Research, 15, pp. 141-151.



Villane, P. M. (1995). A Behavior-based Safety Process Gets Results. Chemical Engineering, 102, 8, p119.

Exercise: Job Hazard Assessment

- Assignment: Jab Hazard Analysis for Formwork
  - The task is to build a concrete footing on the ground. The major four steps involved in the activity are illustrated in the figure below (video source: https://www.youtube.com/watch?v=D5ZMhNEqNMY). For concrete pouring, a concrete pumper will be used. Conduct job hazard analysis (JHA) for the footing construction. (Submission by next class)



- Note:
  1. Any JHA template or the template in the lecture slides (grinding iron casting) can be used.
  2. The objective of this assignment is to understand the concept and procedure of JHA. Only one or two potential hazards / preventive measures for each major step above are required.
  3. Available resource: Construction Safety Association of Ontario (2008). Formwork Health and Safety (https://www.ihsa.ca/PDFs/Products/Id/M064.pdf).

Resource Material

- (Optional Reading) OSHA. Job Hazard Analysis. https://www.osha.gov/Publications/osha3071.pdf?utm_source=rss&utm_medium=rss&utm_campaign=job-hazard-analysis-13

- (Optional Reading) Fred Manuele (2014). Incident Investigation: Our Methods are Flawed. http://www.asse.org/assets/1/7/F1Manuele_10141.pdf

- Jimmie Hinze (1997). Construction Safety, Prentice Hall, New Jersey, USA.

- Construction Industry Institute (1993). Zero Injury Techniques.