FUNDAMENTALS OF RISK ASSESSMENT

Presented by Mr. Rajesh Kandhai

WHO AM I?

- OHSE Manager
- Senior Assessor – STOW TT
- SBCS
- ALJGSB
- bpTT
- EMA – Inspector
- Trinmar
- EMA / UN

SESSION TOPICS

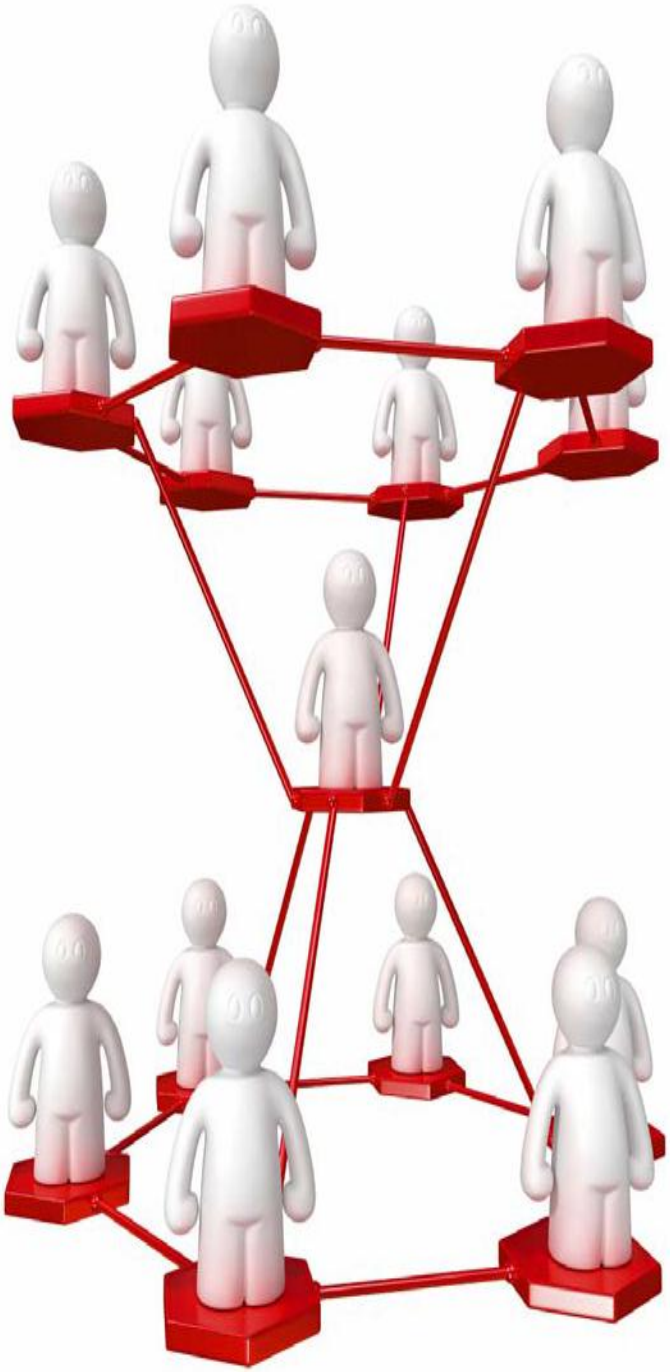
- Introduction and Ground Rules
- Safety Leadership and Safety Culture
- Types of Risk and Assessment Techniques
- Process Mapping
- Hazard Identification
- Hazard Analysis
  - Risk Framework, Risk Assessment, JSA, Toolbox
  - Probabilities, Frequencies and Matrix
- Types of Controls and Mitigation
- Risk Reduction Action Planning

BASIC GROUND RULES

- Start on Time and End on Time
- Participate in discussions
- Respect each other
- Cell phones on silent
- Take calls outside
- Attendance: Be present physically and mentally

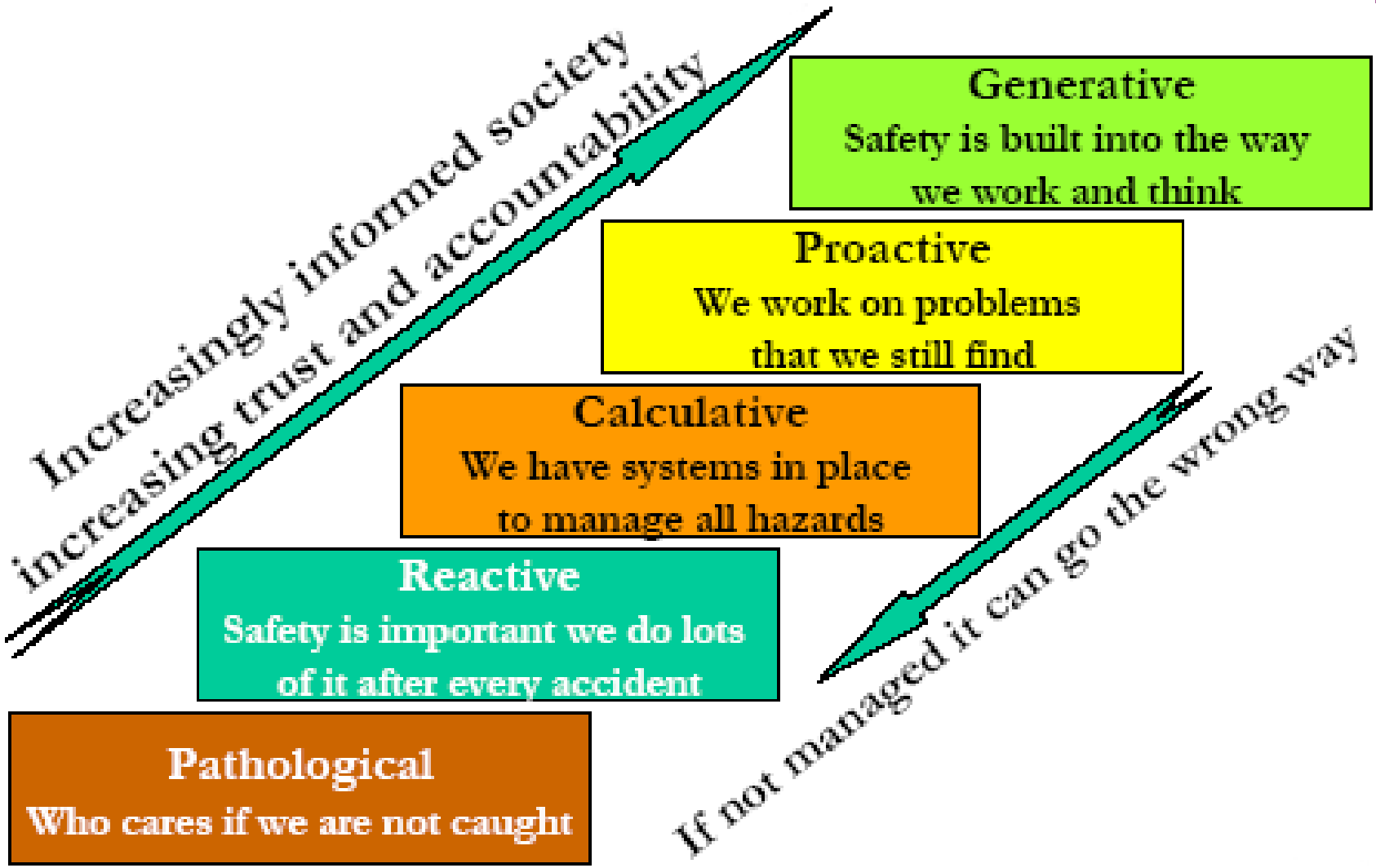
Discussion

What is the difference between a hazard and a risk?



SAFETY LEADERSHIP AND SAFETY CULTURE

TYPES OF SAFETY CULTURE



HSE TOOLS TO IMPROVE CULTURE

HSE REPORTING

- Encourage free, open and honest reporting of HSE performance

INCIDENT INVESTIGATION AND ANALYSIS

- Learn from past mistakes

AUDITING

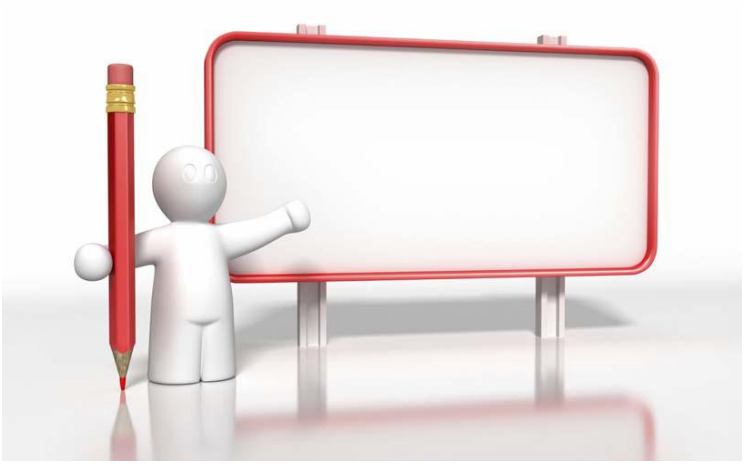
- Verify the HSE performance as accurate

WORK PLACE POLICIES AND PROCEDURES

- Develop standardised methods of executing tasks

HSE TRAINING

- Train your staff



HSE COMMUNICATIONS

- Frequent, relevant and accurate communication

TYPES OF RISK AND ASSESSMENT TECHNIQUES

TYPES OF RISK

- Safety Risk
  - harm people, both onsite and offsite.
- Environmental Risk
  - leads to long term or widespread damage to the environment.
- Business
  - leads to production loss or interruption, project failure or poor project performance, financial loss, reputation damage.

RISK ASSESSMENT DEFINITIONS

STEP	STAGE	
(1)	**Hazard Identification**	Identifying the foreseeable hazards which are either associated with a task, process, or facility, or to which exposure can result by virtue of the physical location.
(2)	**Hazard Severity**	The potential severity they would cause if inappropriate contact were to occur.
(3)	**Hazard Analysis**	Understanding the mechanism by which the hazard makes harmful contact with people or the environment, along with their underlying causes, with an estimation of the likelihood of occurrence.
(4)	**Risk Control**	Understanding the controls that have been provided to (a) prevent the hazard from being realised, or (b) limit the consequences.
(5)	**Risk Analysis**	Combining hazard severity and likelihood of occurrence.
(6)	**Risk Assessment**	Satisfying ourselves that the residual risk, after the effect of preventative or mitigative controls has been accounted for and is tolerable to management.
(7)	**Risk Management**	Using information on which hazards contribute significantly to the residual risk, so that we can target our finite resources to those hazards so that the overall risk can reduced in the most effective manner. Knowledge of what hazards are important and associated control measures can then be used to prioritise inspections and other monitoring activities, so we can assure ourselves of the effectiveness of our defences.

FIVE STEPS TO RISK ASSESSMENT

- Step 1 - Identify the hazards
- Step 2 - Decide who might be harmed and how
- Step 3 - Evaluate the risks and decide on precautions
- Step 4 - Record your findings and implement them
- Step 5 - Review your assessment and update if necessary

CONSEQUENCE OF UNCONTROLLED RISK

- Accidents / incidents
- Near miss
- Injuries
- Legal Responsibilities -The OSH Act, 2004 (as amended) Section 25G
- Damage to reputation
- Financial implication
- Decrease process efficiency

ASSESSMENT TECHNIQUES

What-if

FMEA

PPHA

CHA

ETA

FMECA

FTA

Task

HAZOP

QRA

WHAT IF ANALYSIS

- A creative team brainstorming "what if" questioning approach to the examination of a process or operation to identify potential hazards and their consequences.

- Hazards are identified, existing safeguards noted, and qualitative severity and likelihood ratings are assigned to aid in risk management decision making.

WHAT IF ANALYSIS

- **Advantages:**
  - Team of relevant experts extend knowledge and creativity pool.
  - Easy to use.
  - Ability to focus on specific element (i.e. human error or environmental issues).
- **Disadvantages:**
  - Quality is dependent on knowledge, thoroughness and experience of team.
  - Loose structure can let hazards slip through.
  - Does not directly address operability problems.

FMEA - FAILURE MODE AND EFFECT ANALYSIS

- Assumes that the failure modes of the system component are known.
- The causes of each failure is then evaluated in the system.
- Investigates effects of a single component failure.
- It is not possible to investigate the problem caused by combinations of component failures.

CHA – CONCEPT HAZARD ANALYSIS

- Concept Hazard Analysis is used for the identification of hazard characteristics in an attempt to identify areas which are recognized as being particularly dangerous from previous incidents in the past.

TASK ANALYSIS

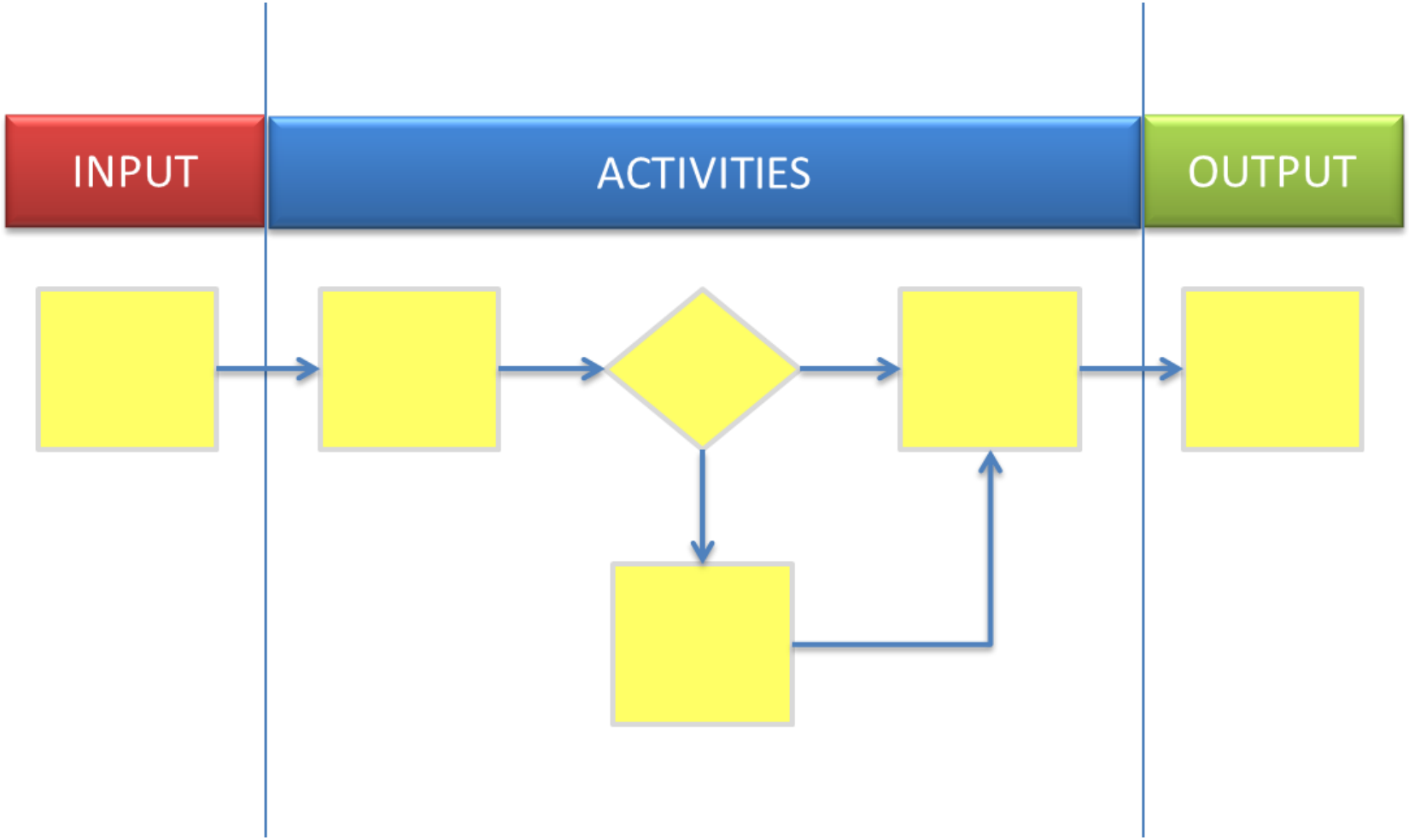
- Task Analysis is a process of sorting out what people might do or actually do when carrying out operations. The analysis must answer to questions such as:
  - What actions do the operators carry out?
  - How do operators respond to different cues in their environment?
  - What errors might be made a deviations caused in plant operations?
  - How any error might be recovered from, or any deviation be controlled?
  - How do operators plan their actions?

HAZOP

- HAZOP is the most widely used method of analysis used in the process industries
- It is recommended for use by legislators, regulators and engineering institutions.
- A HAZOP study is a formal, systematic examination of a processing plant in order to identify hazards, failures and operability problems, and assess the consequences from such maloperation.

PROCESS MAPPING

A SYSTEMATIC APPROACH TO RISK MANAGEMENT



EXERCISE 1

- Lets break into groups of 4 and develop some process maps (lets take 10 minutes).

- Group 1 – focus on a high level / company wide processes.
- Group 2 – focus on a high risk activity such as stack emissions testing.
- Group 3 – focus on a task such as cleaning an office.
- Group 4 – focus on a task such as erecting a scaffold.

EXERCISE 1 - PROCESS MAPPING

Risk Assessment - 2013 - 2014										
Assessment Team :						Date:				
			Unmanaged Risk Ranking				Residual Risk Ranking			
Activity/Operation	Hazard	Who Could be harmed	Severity	Probability of Occurrence	Risk Factor	mitigation measures	residual severity	probability	residual ranking	

Discussion

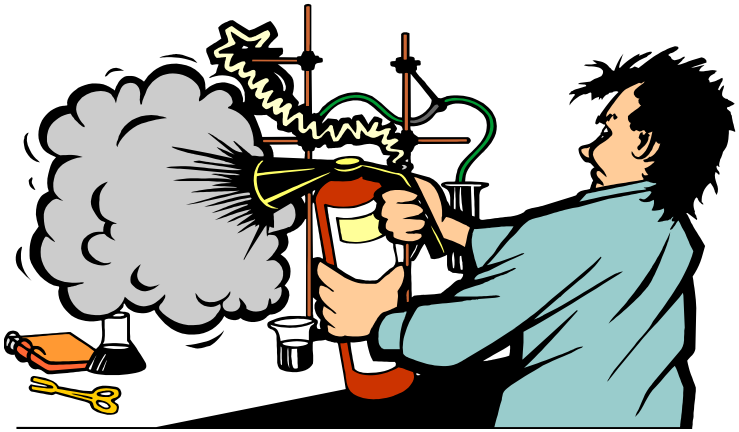
What is the difference between a hazard and a risk?

HAZARD IDENTIFICATION

LETS WATCH A MOVIE HARSCO VIDEO

HAZARD

- To cause harm we have to come into contact with the hazard.
- Hazards are substances or conditions which can cause injury or harm to people, processes, equipment and the environment and which are associated with the properties and behaviors of process materials.



GENERAL HAZARD CATEGORY

- Five broad categories:
  1. Materials
     - Liquids – acids, bases, toxins
     - Solids – wood, metal, plastic
     - Gases – flammables and explosives
  2. Equipment - machinery, vehicles, tools and devices
  3. Environment – noise, temperature, ergonomics, biological
  4. People – employees, guests, contractors, visitors, public
  5. System – flawed policies, programs, plans, procedures, etc.

Types of Hazards

- Hazards may be of varying types:
  - Physical
  - Mechanical
  - Electrical
  - Chemical
  - Biological
  - Ergonomic
  - Psychological
  - Vibration / noise
  - Toxics
  - Radiation
  - Pressure
  - Temperature
  - Flammability
  - Explosives
  - Acceleration

Hazards continued

- After understanding the work to be done, try to identify the possible scenarios:
  - Physical – noise from equipment, temperature in room
  - Mechanical – pinch points, crush points, vehicle collisions
  - Electrical
  - Chemical – exposure, storage, compatibility
  - Ergonomic – strains form tasks (manual handling etc)
  - Psychological – stress from deadlines, work load, unrealistic management requests.

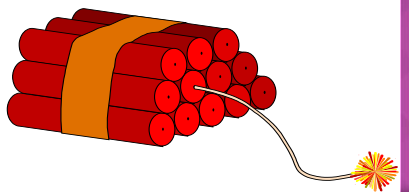
Examples of Hazards

PHYSICAL HAZARDS

- Hydrocarbon with potential for fire or explosion
- High pressure
- Electrical energy
- Potential energy
- Hydraulic Energy
- High temperature surfaces
- Radiation
- Extreme Weather

CHEMICAL HAZARDS

- Hydrogen
- H_2S (toxicity)
- Nitrogen
- Steam
- Hot water
- Pyrophoric materials
- Corrosive materials
- Explosive materials



HAZARD IDENTIFICATION TECHNIQUES

- Safety Observation Program (Formal and Informal)
  - This is considered the most effective proactive method to collect data
- Company Wide Safety Survey
- Employee Interviews
- Safety Inspections (does not adequately identify unsafe behaviours)
- Safety Audits
- Accident Statistics / Investigations
- Document Review

INSPECTIONS

- Workplace inspections are undertaken with the aim of identifying risks and promoting remedial action.
- Such inspections emphasise the safe place approach
  - the identification of unsafe conditions,
  - identification of unsafe acts,
  - over 88% of accidents are caused by unsafe acts of persons,
  - approximately 10% due to unsafe conditions,
  - The remainder are classified as unpreventable i.e. Acts of God!

CHECKLISTS

- Checklists incorporate past experience in convenient lists of do's and don'ts.
  - They may be valuable in the design process for revealing an otherwise un-looked for hazard.
  - They are easy to use and can be expected to reveal most common hazards.
- However, it can become just a ticking exercise, so that anything which is not included in the list is not considered.
  - Checklists usually use closed questions i.e. yes/no answer, so it can be a problem in uncertain situations. They do not provide any quantitative measure or relative ranking.

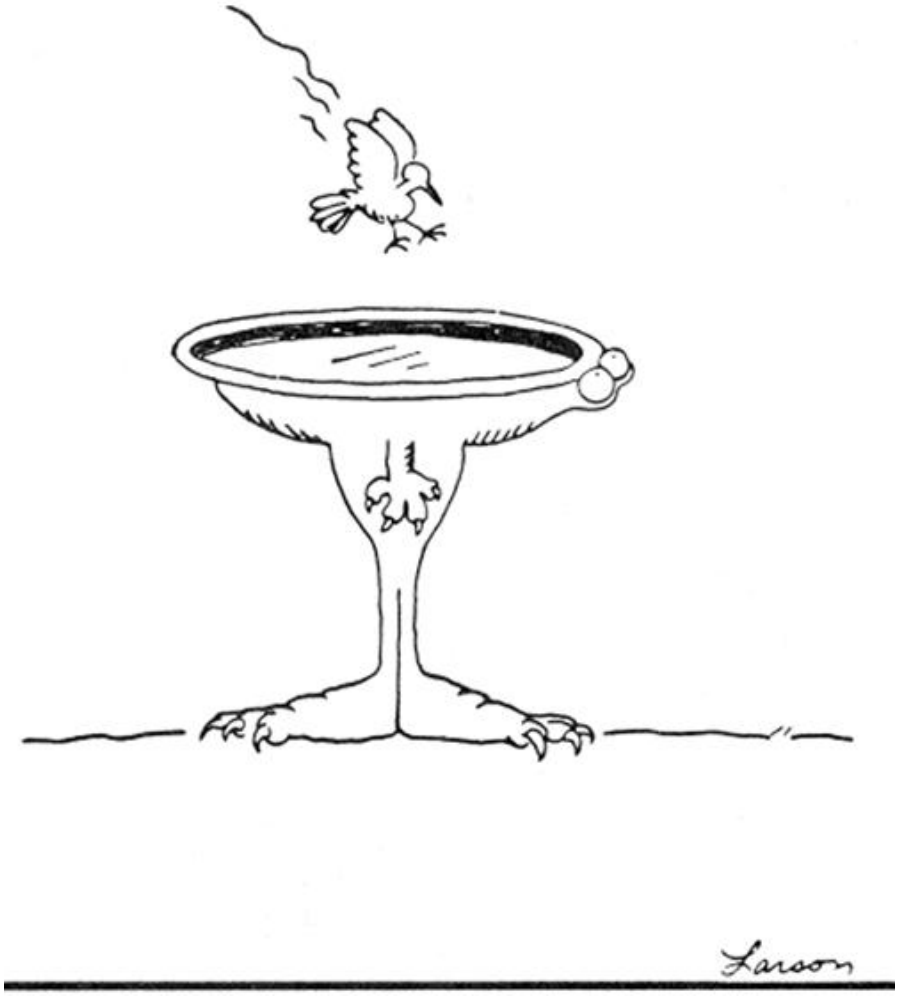
HAZARD SPOTTING

- As a very simple introduction to hazard identification, hazard spotting is a useful exercise – especially if undertaken by competent and experienced personnel.

- It can be undertaken during accident investigations, inspections, auditing and as a precursor to a more formal risk assessment.

Sometimes its easy to spot the hazards

…and sometimes it isn't!



Yet its easy to miss the obvious

EXPOSURE

- The Condition of being exposed OR a position in relation to a hazard.
- Types of exposure:
  - Physical
  - Environmental
  - Potential

Hazard + Exposure ⇨ Accident

LETS WATCH A MOVIE IN THE REAL WORLD

RECAP AND EVALUATION

Hazard Launch E learning tool module 2, 3 and test

EXERCISE 2 - HAZARD IDENTIFICATION

Risk Assessment - 2013 - 2014										
Assessment Team :						Date:				
			Unmanaged Risk Ranking				Residual Risk Ranking			
Activity/Operation	Hazard	Who Could be harmed	Severity	Probability of Occurrence	Risk Factor	mitigation measures	residual severity	probability	residual ranking	

HAZARD ANALYSIS

Risk framework, Risk assessment, JSA, Toolbox, Probabilities, Frequencies and Matrix

RISK FRAMEWORK

Risk is managed at different levels:

- Annual / Company Wide RA
  - At the corporate level an annual facility risk / company wide risk assessment is required.
  - This is mandated by The OSH Act, 2004 (as amended).
  - This is used to identify critical activities.
- Critical Activity Risk Assessments.
  - This is mandated by STOW and requires a high level evaluation of the controls in place for each critical activity and standards adopted to manage them.
- JSA – Done daily / prior to each task.
- Toolbox Talk – the last chance to review and discuss before work begins.

HAZARD CONTROL PROCESS

- Identify Workplace Hazards
- Analyze the workplace
- Develop solutions
- Write recommendations
- Take action
- Evaluate results

RISK

- *"Combination of the likelihood and consequence(s) of a specified hazardous event occurring"*
- **Risk is a function of likelihood x consequences**
- **What's the risk of driving to work?**

LIKELIHOOD / PROBABILITY

- A measure of how likely the hazard will result in the type of harm.
- Done mainly through **experience**.
- Consequences of the hazard will determine the level of harm that would result should its potential be realized.

LIKELIHOOD / PROBABILITY

- This can be either qualitative or quantitative – depends upon the study being conducted.

THE MATRIX

- When used together with the consequence index and the probability index representing the x and y axis, a matrix is generated that can assist in ranking risk.

- This is limited due to the fact that opinions of persons in the group may vary.

Risk Evaluation - Likelihood

Likelihood of occurrence	***Description of rating***	***Rating***
Very Unlikely	Impact highly unlikely to occur	1
Unlikely	Impact unlikely to occur	2
Possible	Impact likely to occur	3
Likely	Impact highly likely to occur	4
Very Likely	Impact Certain to occur	5

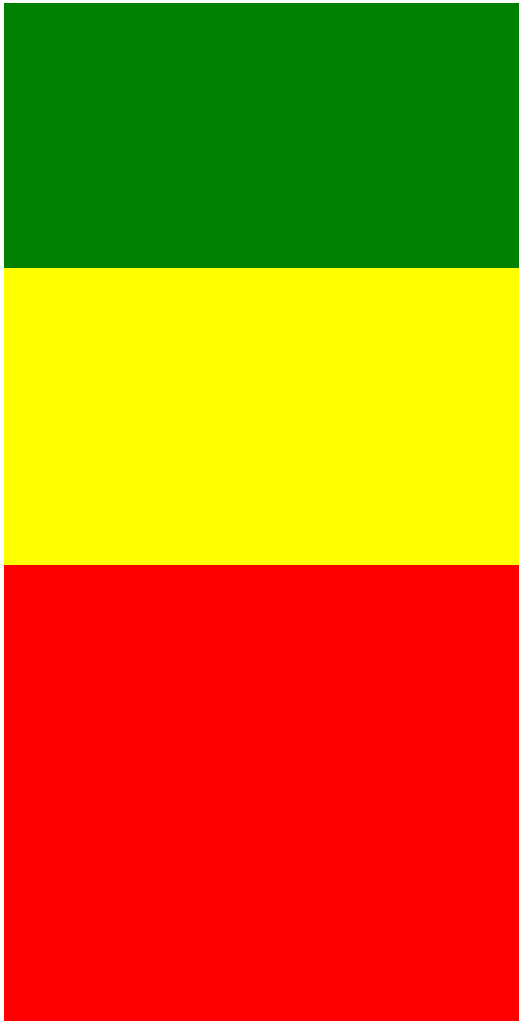
Risk Evaluation - Consequence

Severity	*Severity Definitions*	***Rating***
Negligible	No observable effect	1
Slight	Impact restricted to fewer than three Lost time days	2
Moderate	Minor Fracture - permanent injury/ disability	3
High	Single Fatality	4
Very High	Multiple fatalities	5

Risk Matrix

		Hazard Severity				
		1 Negligble	*2 Slight*	*3 Moderate*	*4 High*	*5 Very High*
Likelihood of Occurrence	*1 Very Unlikely*	***1***	***2***	***3***	***4***	***5***
	2 Unlikely	***2***	***4***	***6***	***8***	***10***
	3 Possible	***3***	***6***	***9***	***12***	***15***
	4 Likely	***4***	***8***	***12***	***16***	***20***
	5 Very Likely	***5***	***10***	***15***	***20***	***25***

Action Levels



No new action required. Continual monitoring of existing controls.

Implement control measures and conduct monitoring to ensure effectiveness.

Activity should not be started or continued until risk reduction measures implemented. **Immediate Action Required.**

EXERCISE 3 – HAZARD ANALYSIS

Risk Assessment - 2013 - 2014										
Assessment Team :						Date:				
			Unmanaged Risk Ranking				Residual Risk Ranking			
Activity/Operation	Hazard	Who Could be harmed	Severity	Probability of Occurrence	Risk Factor	mitigation measures	residual severity	probability	residual ranking	

CASE STUDY HAZARD TOOL

FIGHTING TIME AND STEEL

San Antonio Express-News
MySA.com

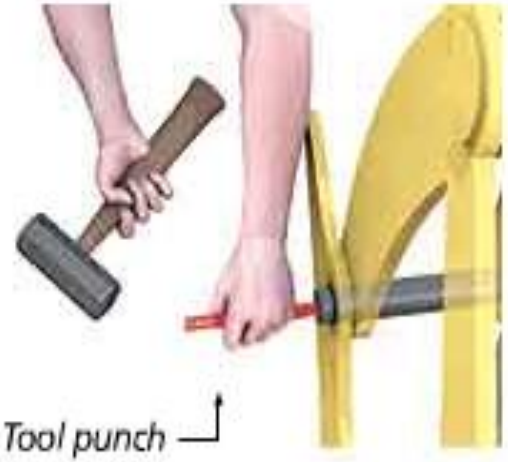
Graphics: Robert Zavala
Flash programming: Harry Thomas

How it happened

At about 8 a.m. Gail Creek and Donnie Masters Jr. were sent to remove the front loading bucket from a backhoe loader. They positioned a forklift under the bucket to haul it away after it was detached.

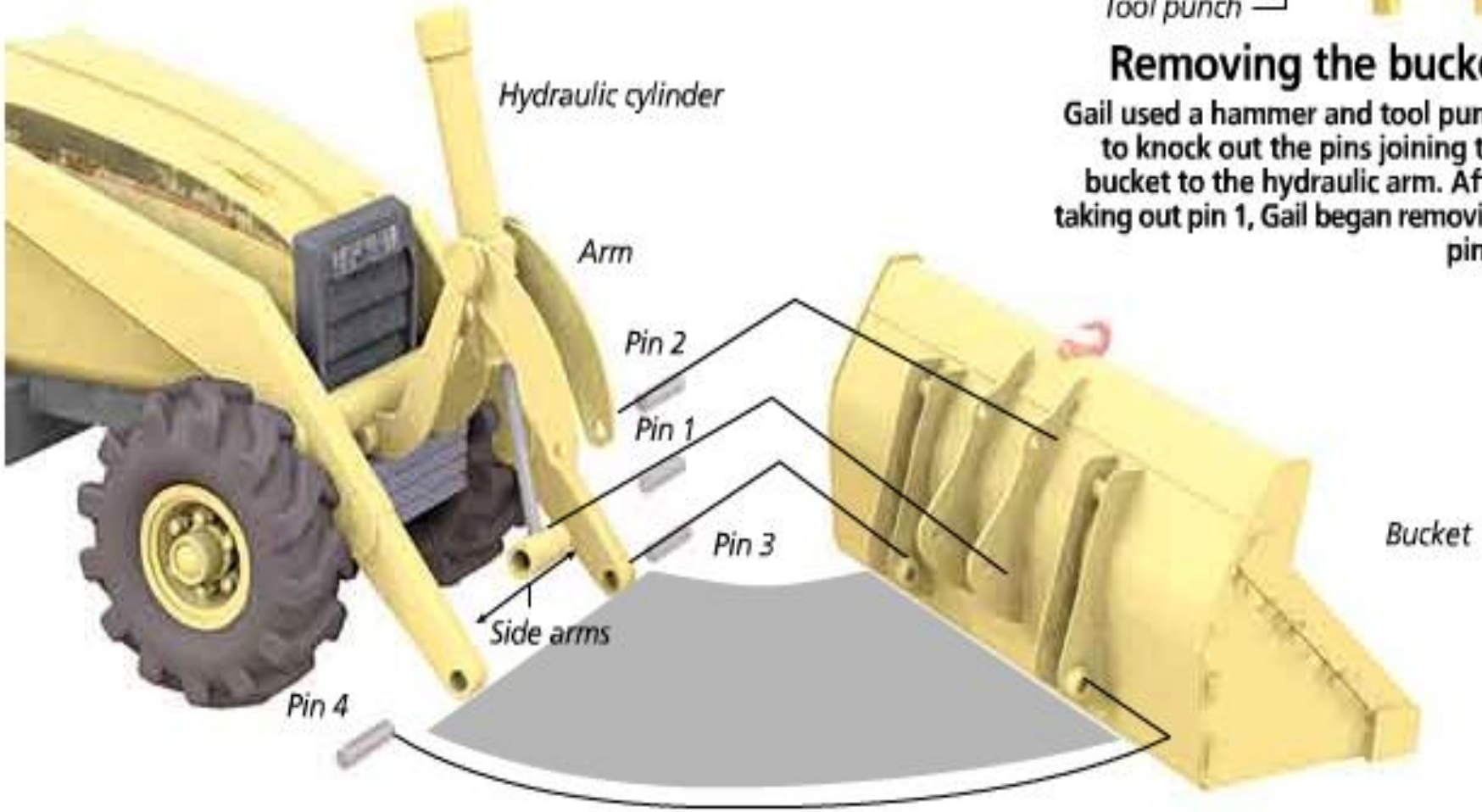
How the bucket was attached

This expanded view shows pins 1 and 2 that attached the bucket to its hydraulic cylinder and arm. These pins supported the weight of the hydraulic system. Pins 3 and 4 attached the side arms and are not weight bearing.



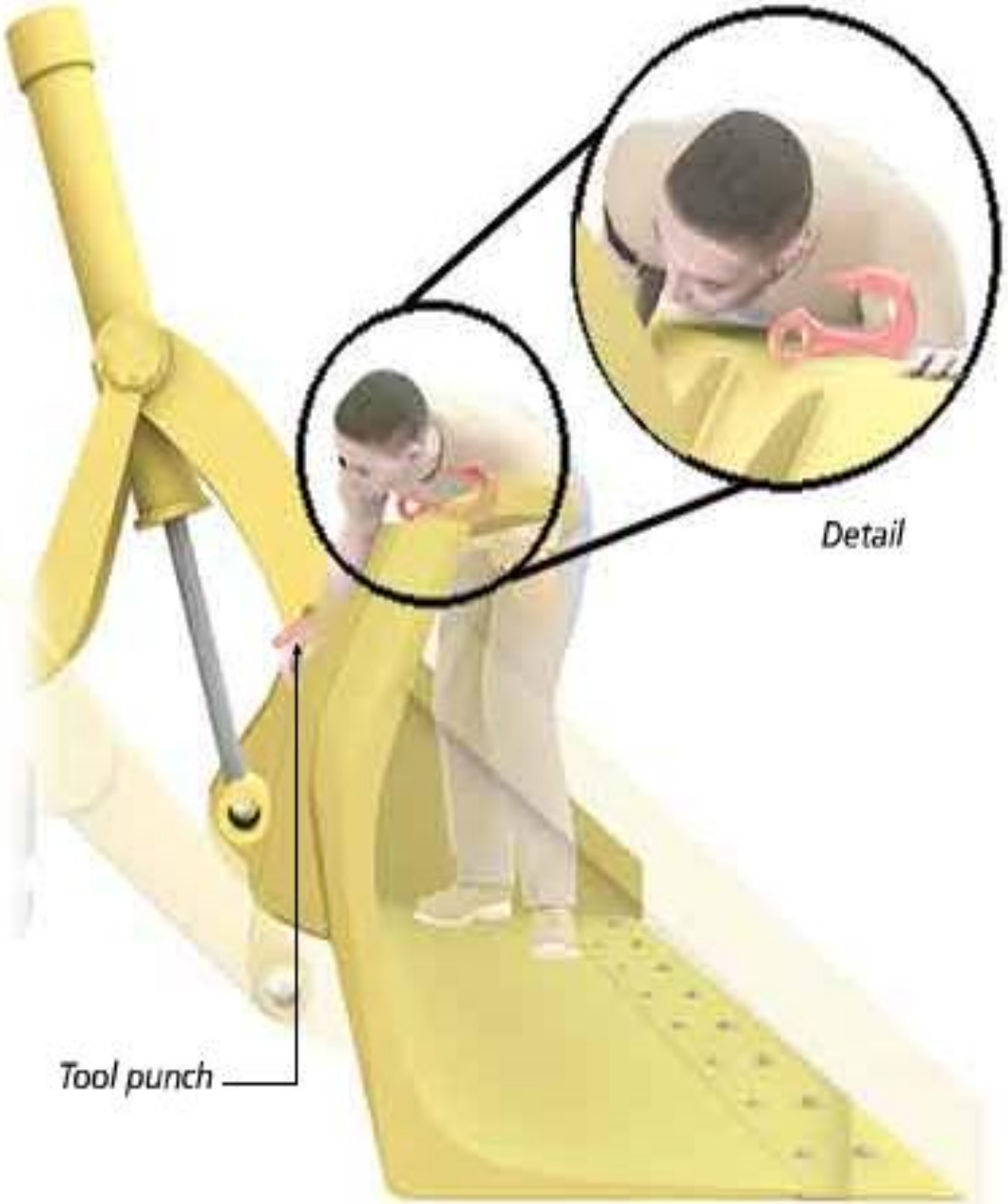
Removing the bucket

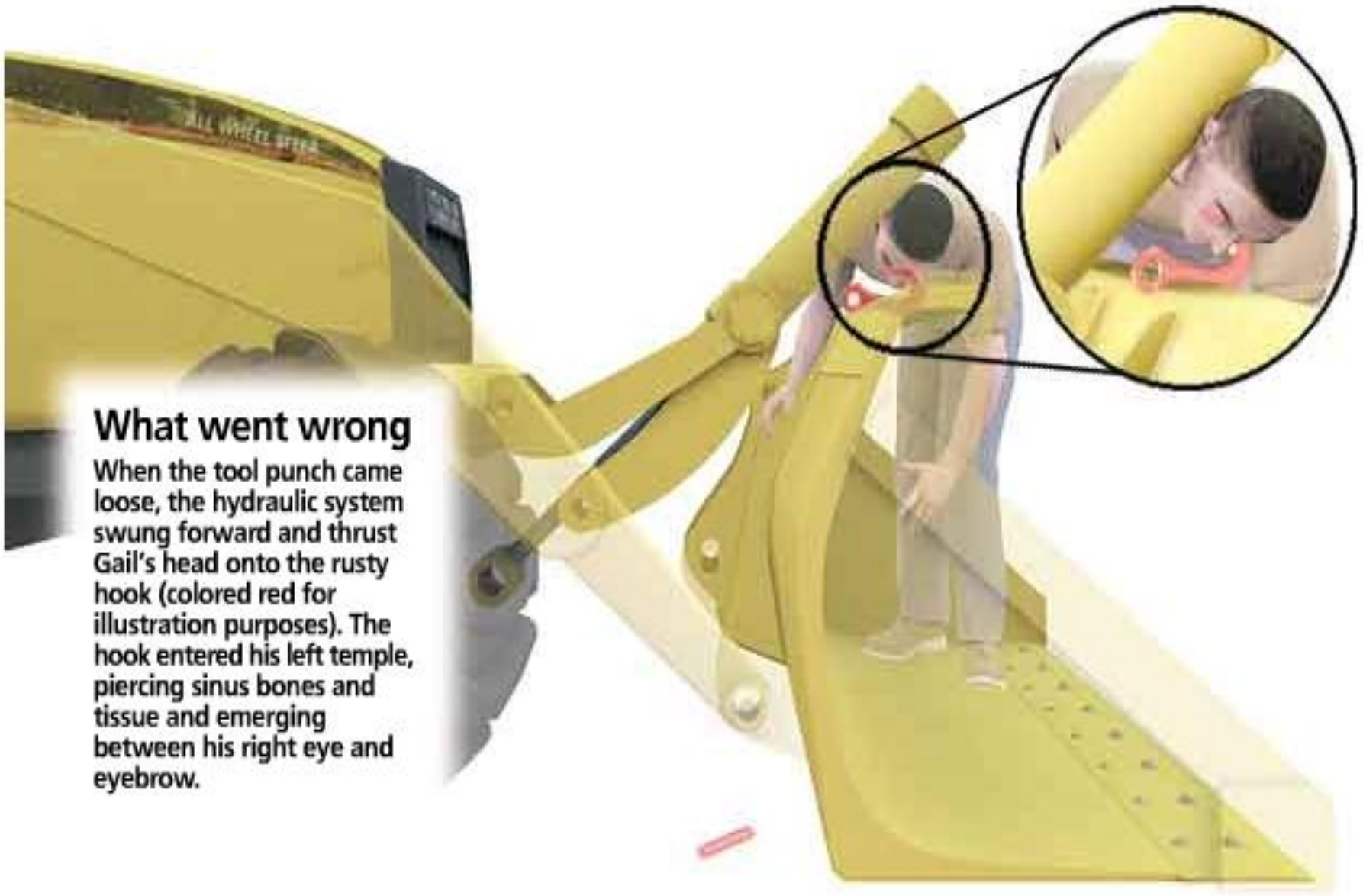
Gail used a hammer and tool punch to knock out the pins joining the bucket to the hydraulic arm. After taking out pin 1, Gail began removing pin 2.



What went wrong

When Pin 2 was pushed out, the tool punch became jammed in the second pinhole. Gail bent over the bucket to inspect it. Gail's head was positioned between the hydraulic arm and the hook welded on top of the bucket. All 126 pounds of the hydraulic system rested on the jammed tool punch.



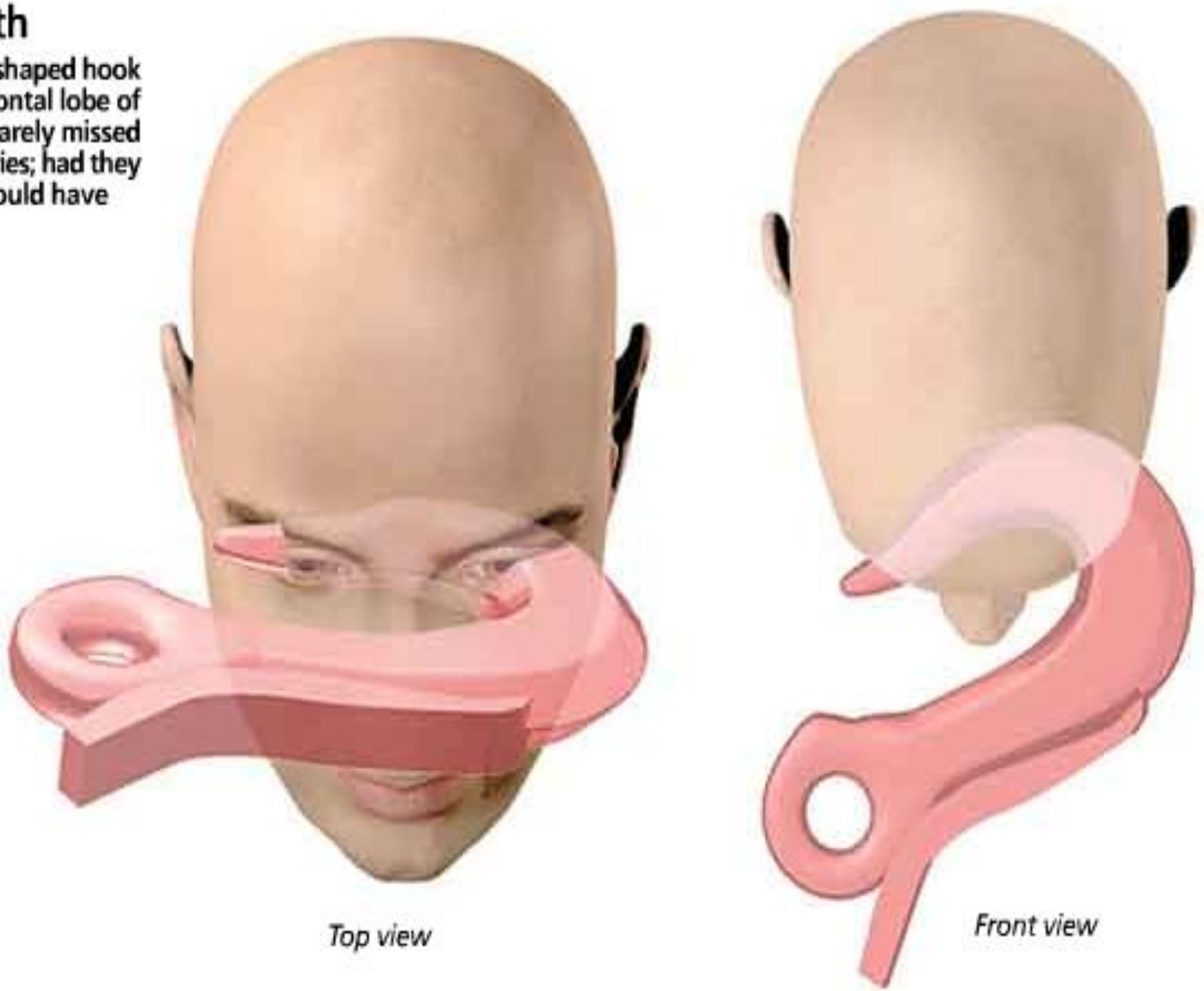


What went wrong

When the tool punch came loose, the hydraulic system swung forward and thrust Gail's head onto the rusty hook (colored red for illustration purposes). The hook entered his left temple, piercing sinus bones and tissue and emerging between his right eye and eyebrow.

A random, almost deadly path

The horseshoe-shaped hook skimmed the frontal lobe of Gail's brain. It barely missed the carotid arteries; had they been cut, he would have bled to death.



Top view

Front view

HAZARD CONTROL

HIERARCHY OF CONTROLS

- Elimination
- Substitution
- Engineering
- Administrative
- PPE

no hazard... no exposure... no accident.

HIERARCHY OF CONTROLS

- Controls at the top are more effective but more expensive.
- Controls at the bottom are less effective but cheaper.
- This creates a conflict that must be managed in the context of feasibility.

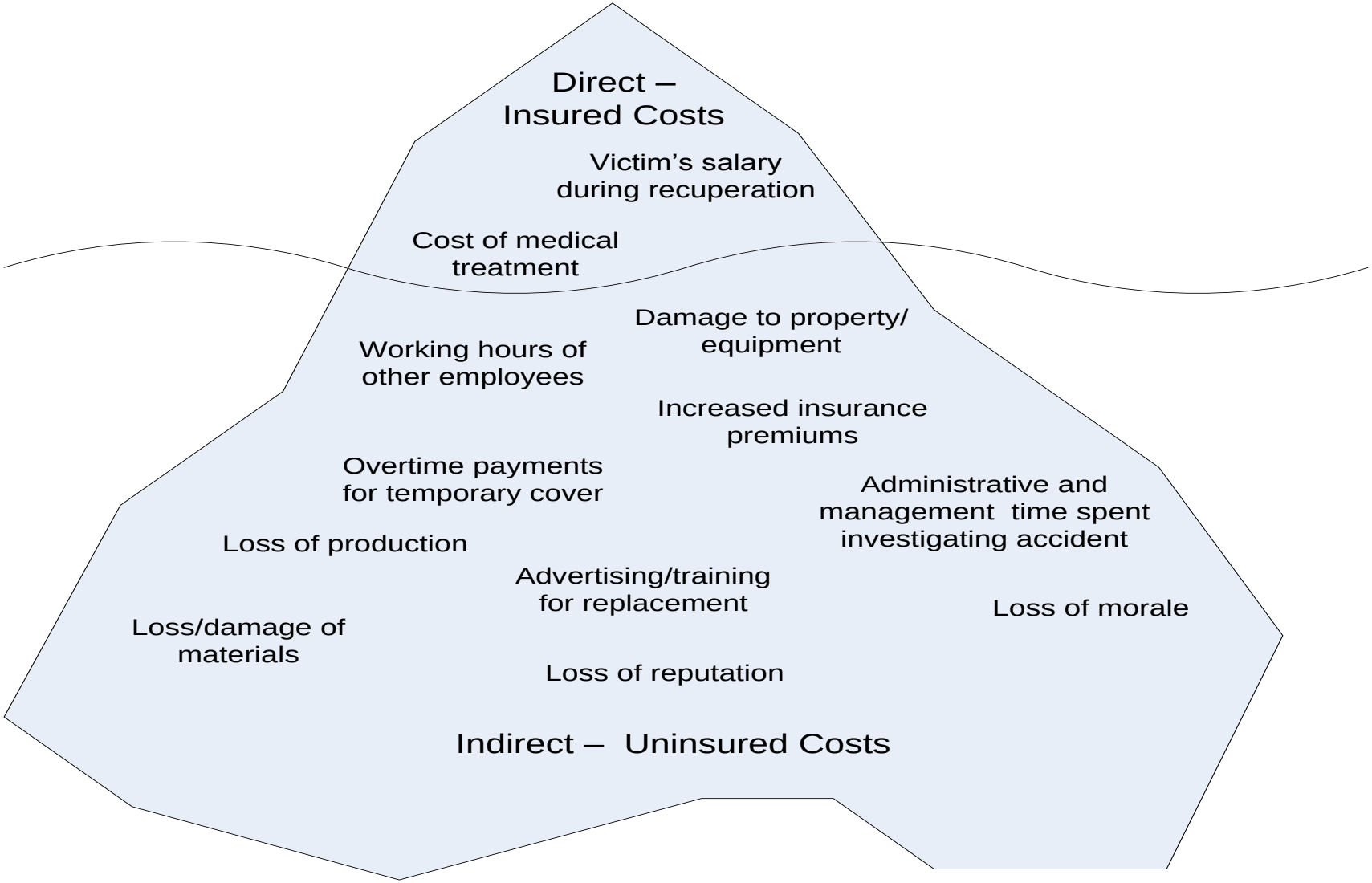
FEASIBILITY

- Technical feasibility
  - Technology exists
  - Is common in the industry
- Economic feasibility
  - The employer must be financially capable of implementing the measures.

ELIMINATION AND SUBSTITUTION

- Most effective
- Most costly
- Most difficult to implement
- Typically easier at the design stage than during retrofit
- Notwithstanding, retrofit costs, these will be less than the indirect costs of accidents.
- Examples:
  - Removing the source of excessive temperature, noise etc.
  - Substituting toxic chemicals with less toxic ones

COST OF INCIDENTS



ENGINEERING CONTROLS

- Looks at the facility design and job process to make it safer.
- Does not focus on the employee.
- Strategies typically include:
  - Design or Redesign
  - Enclosure
  - Barrier
  - Ventilation

Engineering Controls – Design and Redesign

- Redesign the process to use a different or less toxic chemical.
- Redesign the workstation to remove ergonomic hazards.
- Designing ventilation systems to allow sufficient fresh air exchange to allow a healthy atmosphere.

ENGINEERING CONTROLS - ENCLOSURE

- Enclosures are a form of barriers to prevent personnel from coming into contact with the hazards.
- Examples:
  - Fume hoods
  - Enclosing moving parts

ADMINISTRATIVE CONTROLS

- Aimed at reducing the employees exposure to the hazard.
- Looks at safe work practices.
- NOTE Any system that relies on human behaviour is inherently unreliable.
- Administrative controls include polices and procedures.
- Examples include:
  - Housekeeping Procedure
  - Inspections
  - Schedules

PERSONAL PROTECTIVE EQUIPMENT

- The last line of defence.
- It does not control the hazard itself rather controls the exposure.
- Employees must be trained to use Personal Protective Equipment (PPE).

RECAP AND EVALUATION

Hazard Launch E learning tool module 2, 3 and test

EXERCISE 4 - CONTROLS

Risk Assessment - 2013 - 2014										
Assessment Team :						Date:				
			Unmanaged Risk Ranking				Residual Risk Ranking			
Activity/Operation	Hazard	Who Could be harmed	Severity	Probability of Occurrence	Risk Factor	mitigation measures	residual severity	probability	residual ranking	

RISK REDUCTION ACTION PLAN

Risk / Hazard / Activity	Mitigation Measure	Applicable process / location	Responsible Person	Due Date	Status
Noise	Conduct noise mapping exercise to identify hearing protection zones	Carpenter’s shop			

EXERCISE 5

- *Now that you have had some practice, lets look at an everyday non work related example.*
- *Imagine yourself on a tropical beach with a fringe of palm trees.*
- *There is some suggestion that there may be sharks relatively close to the beach but there have been no attacks on bathers in this area.*
- *You have the choice to stay under the shade of a coconut palm or go for a swim knowing that there are sharks in the area.*
- ***Which would you choose and why?***

DISCUSSION

- In a typical year, around 10 – 12 people are killed world-wide by shark attacks while around 160 people each year are killed by falling coconuts.

DISCUSSION

- Surprisingly (or not!) coconut palms are a much higher risk than sharks.

RISK PERCEPTION

- The perception of risk by those who are exposed to it.

- **Perception** is the process of acquiring, interpreting, selecting and organizing sensory information.
  - people may actually not perceive a real risk.
  - different people may perceive the same risk in very different ways (note this).

RISK PERCEPTION

- Perception depends on many individual traits such as:
  - Upbringing, education, training, experience, attitude, personality, organizational culture etc.
  - Take for example driving on the roads of Trinidad and Tobago, is this high risk? To a local it may or may not be but for a foreigner, they may be traumatized by the experience.
  - How would you feel driving in another country for example Egypt or Azerbaijan?

RISK PERCEPTION

- As a result of these personality traits, individuals will make:
  - assumptions, judgments and estimates, and can express opinions.
  - In the workplace this inconsistent perceptions cannot be allowed as this can result in accidents.
  - Perceptions affect behaviors.