‘To say accidents are due to human failing is like saying falls are due to gravity. It is true but it does not help us prevent them.’

Trevor Kletz

The aim today is to talk about methods that are known to help identify human failure in accident investigation and prevent reoccurrence.

It is not a black art, but a pragmatic and robust process.
Alberta sees five fatal workplace accident in one week

Emily Mertz, Global News : Friday, October 19, 2012 10:55 AM

Since Monday, October 15th, five people have lost their lives in workplace accidents across our province.

The most recent death happened early Friday morning, when a 29-year-old man was crushed between a track hoe and a flare tank after the track hoe operator activated the controls. Brookes Merritt, communications with Occupational Health and Safety says the accident happened at an Ensign Drilling location about 25 kilometres south
A 35-year-old man has died after a tragic forklift accident at a local tire shop. The man, whose name has not been released, was working for Mo Tires Ltd. in Lethbridge fuelling up a forklift around 1:30 p.m. Wednesday when he became fatally pinned between the forklift and a nearby shed. He was taken to hospital, where he was pronounced dead, according to Alberta Occupational Health and Safety.

Officials from Occupational Health and Safety (OHS), a division of the provincial department of Human Services, were on scene Wednesday afternoon at 2830 5 Avenue North to investigate along with Lethbridge regional police officers.
"This is the first time in 75 years, and hopefully the last," said Bill Wright, the Manager of Mo Tires, of the fatality.

"People make mistakes, and sometimes there is extreme result of that," added Wright. "What we have to send a message to workers to be on their toes, be careful, follow the procedure, follow the rules. Nobody's exempt from having something bad happen. A lot of times people take things for granted, and a lot of us have to be more careful."
What are we trying to achieve?
Who owns the risk of worker errors?

Internal Responsibility System

- Director
  - Principles
- President
  - Policies
  - Systems
- Vice President
  - Programs
- Manager
  - Programs
- Supervisor
  - Coaching
  - Problem-solving etc.
- Worker
  - Initiative
  - Problem-solving
  - Conformance
  - Reporting
What Jobs Result in Accidents?

"Jobs with high task demands and little control over how the tasks are to be completed, are the most likely to result in employee disability."
The Real Problem

Workers:

• are weak
• they don’t know
• they don’t care
• they get tired
• they forget
• they are lazy
• they are stressed
• they don’t follow rules
• they are easily confused

But you need them to run your organization so…..we need to figure this out!
Risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss.

I think we forget this because we believe our hazard assessment and control processes are strong.
Simplified Risk Assessment

ASK THE SIMPLE RISK QUESTIONS!

Why — am I doing it at all?
What — could go wrong?
How — could it affect me or others?
How — likely is it to happen?
What — can I do about it?
Herbert Heinrich’s Domino Theory

80% of unwanted outcomes are caused by human error.

Heinrich’s 1930s model suggests accidents are caused by “unsafe acts”

What is the cause of the error?

Figure 14 – H.W. Heinrich’s Domino Theory of Accident Causation from the 1930’s
Human Error

What is the cause of the error?

Unwanted Outcomes

- 80% Human Error
- 20% Equipment Failures

70% Latent Organization Weaknesses

30% Individual

Taken from: Shane Bush, Bushco, Idaho Falls, ID
Herbert Heinrich’s Domino Theory

Model suggests accidents are caused by “unsafe acts”

Figure 14 – H.W. Heinrich’s Domino Theory of Accident Causation from the 1930’s
Supervisors Can Control “Unsafe Acts”

The “system” remains unchanged and the worker remains “defective”

Supervisor intervenes to prevent “unsafe act”

No Accident

This might work but is this systems “scalable” or “sustainable”? 
Frank Bird’s Original Domino Theory

Bird referred to *incident* instead of *accident* and broadened the model to include damage to property.

Unsafe acts and unsafe conditions are due to lack of control by management.

Bird asks us to look to the “system” to build something “scalable” and “sustainable”? 
Bird’s Updated Accident Sequence

Lack of Control
1. Inadequate Program
2. Inadequate Program Standards
3. Inadequate Compliance to Standards

Basic Causes
- Personal Factors
- Job Factors

Immediate Causes
- Substandard Acts and Conditions

Incident
- Contact with Energy or Substance

Loss
- People
- Property
- Process

Analysis of Loss
Germain’s Modified Model

**Inadequate Control**
- System
- Roles & Responsibilities
- Compliance

**Underlying Causes**
- Individual Factors
- Work Factors

**Immediate Causes**
- Substandard Acts/Practices/At-Risk Behaviors
- Substandard Conditions

**Event (Incident)**
- Potential Loss Producing Event

**Harm Threshold**
- Unintended Harm or Damage

**Problem Solving Model**
Accident Caused by Failure to Secure
Accident Caused by Failure to Secure

November 10, 2004 - Calgary
Taxonomy of Human Error

MISTAKES

Knowledge

Rule

Interpretation

Situation Assessment

Plan

Intention of Action

SLIPS

Action Execution

LAPSES and MODE ERRORS

Memory
Human Error Taxonomy

James Reason (1992)

- Basic Errors
  - Slip
  - Lapse
  - Mistake
  - Violation

- Unsafe Acts
  - Intended Action
  - Unintended Action

- Rule-based or Knowledge-based Mistakes
- Routine violations
- Exceptional violations
- Sabotage

- Attentional Failures
- Memory Failures

- Routine violations
- Exceptional violations
- Sabotage
Factors that cause/contribute to accidents

The systems approach - accidents occur because of the interaction between system components

Direct causal factors in safety:

1. The employee performing a task
2. The task itself
3. Any equipment directly or indirectly used in the task
4. Other factors - social/psychological and environmental
Factors affecting hazard recognition, decisions to act appropriately, and ability to act appropriately:

Age and Gender
younger people have more accidents - ages 15-24, mostly young males

Job Experience
70% of accidents occur within the first 3 years

Stress, Fatigue, Drugs, and Alcohol
many employers drug test
Job characteristics – such as high physical workload, high mental workload, monotony, etc…

Equipment - where most of the safety analysis is performed. This is due to problems with:

Controls and Displays (e.g. poorly designed, difficult to use, cumulative trauma, etc.)

Electrical Hazards (e.g. occurs when a person is doing repairs and another person unknowingly turns the circuit on)

Mechanical Hazards (results in cutting of skin, shearing, crushing, breaking, or straining)

Pressure and Toxic Substance Hazards (asphyxiants, irritants, systemic poisons, and carcinogens)
The Physical Environment

Illumination - glare, phototropism, contrast

Noise and Vibration - affects dexterity, control, and health

Temperature and Humidity - heat exhaustion, inattention, restrictive clothing

Fire Hazards - open flames, electric sparks, and hot surfaces

Radiation Hazards - Radioactive material - damage to human tissue

Falls - resulting in injury or death are relatively common
The Social Environment

Human behavior is influenced by social context

Social norms, management practices, morale, training, incentives (e.g. construction workers will not wear safety gear if no one else is)

Creates the mechanism for “normalized deviance”.

Normalization of Deviance
Human Error Taxonomy

James Reason (1992)

Basic Errors

Slip
- Attentional Failures

Lapse
- Memory Failures

Mistake
- Rule-based or Knowledge-based Mistakes

Violation
- Routine violations
- Exceptional violations
- Sabotage

Unsafe Acts

Unintended Action

Intended Action
Human Error Taxonomy

James Reason (1992)

Basic Errors

Slip

Attentional Failures

Lapse

Memory Failures

Mistake

Rule-based or Knowledge-based Mistakes

Violation

Routine violations
Exceptional violations
Sabotage

Unsafe Acts

Unintended Action

Intended Action
Chemical exposure by inhalation, ingestion and skin absorption
Human Error Taxonomy

James Reason (1992)

Basic Errors

- **Slip**
  - Attentional Failures

- **Lapse**
  - Memory Failures

- **Mistake**
  - Rule-based or Knowledge-based Mistakes

- **Violation**
  - Routine violations
  - Exceptional violations
  - Sabotage

Unsafe Acts

- Intended Action
- Unintended Action
Human Error Taxonomy

James Reason (1992)

Basic Errors

- Slip
- Lapse
- Mistake
- Violation

Unsafe Acts

- Unintended Action

Intended Action

- Routine violations
- Exceptional violations
- Sabotage

Attentional Failures

Memory Failures

Rule-based or Knowledge-based Mistakes
<table>
<thead>
<tr>
<th>Error Mechanism Categories</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skill Based:</strong></td>
<td>Attention Failures</td>
</tr>
<tr>
<td></td>
<td>Memory Failures</td>
</tr>
<tr>
<td></td>
<td>Failures in Execution</td>
</tr>
<tr>
<td><strong>Perceptual Based:</strong></td>
<td>Visual</td>
</tr>
<tr>
<td></td>
<td>Auditory</td>
</tr>
<tr>
<td></td>
<td>Tactile</td>
</tr>
<tr>
<td><strong>Rule Based:</strong></td>
<td>Misapplication of a good rule</td>
</tr>
<tr>
<td></td>
<td>Application of a bad rule</td>
</tr>
<tr>
<td><strong>Knowledge Based:</strong></td>
<td>Inaccurate knowledge of the system</td>
</tr>
<tr>
<td></td>
<td>Incomplete knowledge of the system</td>
</tr>
</tbody>
</table>
Intrusion – entering a dangerous area / location

Commission – performing an act incorrectly

Omission – failure to do something

Reversal – trying to stop or undo a task already initiated

Mis-ordering – task or set of tasks performed in the wrong sequence

Mis-timing – person fails to perform the action within the time allotted
## Accident Pre-curserers

<table>
<thead>
<tr>
<th>Task Demands</th>
<th>Individual Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time pressure (in a hurry)</td>
<td>Unfamiliarity w/ task / First time</td>
</tr>
<tr>
<td>High Workload (memory requirements)</td>
<td>Lack of knowledge (mental model)</td>
</tr>
<tr>
<td>Simultaneous, multiple tasks</td>
<td>New technique not used before</td>
</tr>
<tr>
<td>Repetitive actions, monotonous</td>
<td>Imprecise communication habits</td>
</tr>
<tr>
<td>Irrecoverable acts</td>
<td>Lack of proficiency / Inexperience</td>
</tr>
<tr>
<td>Interpretation requirements</td>
<td>Indistinct problem-solving skills</td>
</tr>
<tr>
<td>Unclear goals, roles, &amp; responsibilities</td>
<td>“Hazardous” attitude for critical task</td>
</tr>
<tr>
<td>Lack of or unclear standards</td>
<td>Illness / Fatigue</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work Environment</th>
<th>Human Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distractions / Interruptions</td>
<td>Stress (limits attention)</td>
</tr>
<tr>
<td>Changes / Departures from routine</td>
<td>Habit patterns</td>
</tr>
<tr>
<td>Confusing displays or controls</td>
<td>Assumptions (inaccurate mental picture)</td>
</tr>
<tr>
<td>Workarounds</td>
<td>Complacency / Overconfidence</td>
</tr>
<tr>
<td>Hidden system response</td>
<td>Mindset (“tuned” to see)</td>
</tr>
<tr>
<td>Unexpected equipment conditions</td>
<td>Inaccurate risk perception (Pollyanna)</td>
</tr>
<tr>
<td>Lack of alternative indication</td>
<td>Mental shortcuts (biases)</td>
</tr>
<tr>
<td>Personality conflicts</td>
<td>Limited short-term memory</td>
</tr>
</tbody>
</table>
Performance Modes--Attending Problems

- Knowledge-Based Patterns
- Inaccurate Mental Picture
- Rule Based
  - If-Then
  - Skill-Based
  - Auto
- Inattention

Attention (to task)

Low

Familiarity (w/ task)

Low

High
**Taxonomy of Human Error Mistakes**

**Mistakes** – failure to come up with appropriate solution. Takes place at level of perception, memory, or cognition.

Knowledge-based Mistakes – wrong solution because individual did not accurately assess the situation. Caused by poor heuristics/biases, insufficient info, info overload.

Rule-based Mistakes – invoking wrong rule for given situation. Often made with confidence.
Taxonomy of Human Error Slips

**Slips** – Right intention incorrectly executed (oops!)

**Capture errors** – similar situation elicits action, which may be wrong in “this” situation. Likely to result when:

1. Intended action is similar to routine behavior
   - Hitting enter key when software asks, “sure you want to exit without saving?”
2. Either stimulus or response is related to incorrect response
   - Hit “4” instead of “#” on phone to hear next message, because “4” is what I hit to hear the first message
3. Response is relatively automated, not monitored by consciousness
   - Re-starting your car while the engine is already running
Lapses & Mode Errors

**Lapses** – failure to carry out an action
- Error of Omission (working memory)
- Examples: Forgetting to close gas cap, failure to put safety on before cleaning gun, failure to remove objects from surgical patient

**Mode Errors** – Making the right response, but while in the wrong mode of operation
- Examples: leave keyboard in shift mode while trying to type a numeral, driving in wrong gear, going wrong direction because display was north-up when thought it was nose-up
Error Prevention / Remediation

Task Design
Design tasks with working memory capacity in mind

Equipment Design
Minimize perceptual confusions/ease of discrimination
  e.g. airplane controls that feel like what they do (flaps, wheels)
Make consequences of action visible/immediate feedback
  e.g. preview window in some software programs
Lockouts – design to prevent wrong actions
  e.g. car that will not let you lock door from outside without key
Reminders – compensate for memory failures
  e.g. ATM reminds you to take your card
Error Prevention / Remediation

Training – provide opportunity for mistakes in training, so can learn from them
  e.g. Simulation

Assists and Rules – checklists to follow
  e.g. Pilot pre-flight checklist

Error-tolerant systems – system allows for error correction or takes over when operator makes serious error
  e.g. Undo button
The Blame Cycle

- Human Error
- More flawed defenses & error precursors
- Individual counseled and/or disciplined
- Latent organizational weaknesses persist
- Management less aware of jobsite conditions
- Less communication
- Reduced trust

Blame Cycle
What is the value of COR?

This certificate recognizes that

EHS PARTNERSHIPS LTD.

In keeping with the principles of Partnerships has:

- developed and implemented a workplace health and safety management system and,
- met the standard for Partnerships through an independent evaluation of their health and safety system.

Manufacturers' Health & Safety Association
Partner in Health and Safety
Certificate # 20070529-3999
WCB Industry Code(s): 86922

Joe Childs
Director, Workplace Partnerships

Expiry Date: May 29, 2010
1. Data collection (4 Ps)
2. Data Analysis
3. Corrective Action
Human Error Taxonomy

James Reason (1992)

Basic Errors

- Slip
- Lapse
- Mistake
- Violation

Unsafe Acts

- Intended Action
- Unintended Action

Attentional Failures
Memory Failures
Rule-based or Knowledge-based Mistakes
Routine violations
Exceptional violations
Sabotage
What to remember

• Human behaviour can be predicted with reasonable accuracy
• Correctly integrating Human Factors into your accident investigation process *will* reap rewards – just look at the contemporary causation theories
• Separating error, mistake and violation represents a highly valuable first step
• Employee selection and competency development is a big part of error risk management
A final thought…

The most powerful influence on human behaviour is outcome. Therefore managing human failure requires a high degree of corporate honesty:

• What behaviour is really rewarded?
• Are we willing to look at organizational factors, especially when we see rule breaking?
• Are we willing to make the investments that are needed to prevent reoccurrence?
• Are we willing to strive for objectivity and pragmatism?
Questions??
Please feel free to contact me directly

Glyn Jones, M.A.Sc., P.Eng., CIH, CRSP
Partner
Cell: 403.630.3854

EHS Partnerships Ltd.
4303 - 11th Street SE
Calgary, AB T2G 4X1

Tel: 403.243.0700
Fax: 403.243.0760
Email: gjones@ehsp.ca
The Relationship Between Transformational and Transactional Leadership

Leadership
- Transformational Focus
- Soft/Relationship Skills
  - Adaptability
  - Communication
  - Delegating
  - Ethics
  - Leadership Confidence
  - Listening
  - Motivating Others
  - Relationship Building
  - Visioning

Management
- Transformational Focus
- Soft/Relationship Skills
  - Employee Development
  - Organizing
  - Planning/Goal Setting
  - Performance Appraisal
  - Performance Feedback
  - Problem Solving
  - Rewards
  - Accountability

Transformational Behaviours
- Low Frequency
- High Frequency

Transactional Behaviours
- Low Frequency
- High Frequency

Sweet Spot
Top 20%
In Canada environmental, health and safety regulations are promulgated provincially.
OH&S Management is a General Duty of Employers

Obligations of employers, workers, etc.

2(1) Every employer shall ensure, as far as it is reasonably practicable for the employer to do so,

(a) the health and safety of

(i) workers engaged in the work of that employer, and

(ii) those workers not engaged in the work of that employer but present at the work site at which that work is being carried out, and

(b) that the workers engaged in the work of that employer are aware of their responsibilities and duties under this Act, the regulations and the adopted code.

This is the written requirement of the Occupational Health and Safety Act in Alberta
IRS System

- Director
- President
- Vice President
- Manager
- Supervisor
- Worker

- Principles
- Policies
- Systems
- Programs
- Coaching
- Problem-solving
- etc.
- Initiative
- Problem-solving
- Conformance
- Reporting
Components of a Workplace Health and Safety Program

- Company policy and management commitment
- Worker qualifications, orientation and training
- Hazard identification
- Hazard control
- Ongoing inspections
- Emergency response
- Incident investigation
- Program administration
Case Study of a Multi-Worker-Error Incident

...a worker is up 10 feet on a scaffold doing maintenance work in a warehouse. A tool is “accidentally” kicked off the scaffold floor and falls striking the operator of a forklift below. The forklift driver receives a minor contusion on his forearm.
Case Study of a Multi-Worker-Error Incident

The loss is the bruised forearm (and there may have been other losses too). The immediate causes are the tool falling from the floor of the scaffold and the forklift truck driver ignoring the banner tape installed to restrict access to the work area. An indirect cause of the falling tool is that the maintenance worker failed to install toe boards on the scaffold when constructing it.
An indirect cause of the forklift truck driver ignoring the banner tape is poor lighting in the area and improper placement of the banner tape by the maintenance foreman.

Further distal causes are related to; the lighting levels which are a poor design or not maintained, and why the maintenance supervisor failed to install the banner tape properly (the stores ran out of banner tape and the supervisor asked a junior maintenance employee to install the banner tape).

What workers made errors???