In the safety profession an investigation refers to a reactive analysis. Auditing refers to an investigation that is proactive in nature. Reactive means that we are examining a failure after it has occurred and become known to us. Proactive means that we are assessing for possible failure prior to a known report or occurrence. We are also advocating that successes become analyzed. This may fall into the category of auditing, since a known failure has not actually occurred. In analyzing successes, it is important to identify what common criteria are established in processes, work stations, machines, or any organizational project that lend it to less failure or increased performance.

The goal of any management system for safety is for the organization to learn from its experience. Experience involves failures and successes. In order to learn it must gather, document, and track the relevant data, it must investigate certain occurrences, implement countermeasures, reassess the effectiveness of its countermeasures, and communicate to its membership the data produced from the learning system. Activity can be categorized as proactive or reactive. Of course the goal is to increase proactive activity like employee hazard recognition and self-assessment audits, to include documenting best practices from effective projects, countermeasures, and high performing processes. Reactive activity hinges on accurate investigations.

An investigation is not a fact finding tour alone. An investigation is uncovering of chronological observable events, aligned with all conditions and factors present chronologically, that produces a countermeasure from a causal analysis. This is true of criminal investigations, civil investigations, workplace investigations. They all produce a countermeasure. Once implemented the countermeasure must be assessed for effectiveness and if necessary, examined for accuracy and modified to increase effectiveness.

**Root Cause**

An investigator must identify the observable events, answering who, what, where, when, how, and why for each event. Events align with conditions that are either constant throughout the entire sequence of events, or are specific to one event. For this reason root cause analysis does not mean that one cause is central.

Root cause divides cause into two levels; immediate and root. Immediate level consists of two categories; substandard conditions and undesirable or unsafe acts. Root cause level has three factors that must be uncovered; job factors, personal factors, and management system factors. For each event we must identify these categories that are present in answering who, what, where, when, why, and how. Root cause is aligning the events with the concurrent conditions. It premises that the overall occurrence could not or would not have happened except for the situational alignment of events and conditions. More than one event with certain conditions present allows for the incident to develop as it did. In effect, root cause analysis is multiple causes.

Throughout our program you have been introduced to theories of accident causation. In OSH 261 you were introduced to the Domino Theory and Bird’s Root Cause Model. In OSH 367 you learn about the Life Changing Units Theory, where life events are given stress ratings and stress creates more potential form human error. In OSH 379 you watched Joe Tanturelli speak about his survival of a trench collapse. He pointed out the fatal four present in most incidents; time stress (hurry), frustration, complacency, and fatigue. In other courses you are asked to recognize hazards and substandard conditions, recognize unsafe acts, and now are beginning to look at management systems and find
where the weak point is from a management and leadership side. These all combine to help the investigator to look for and identify the root cause elements present in Bird’s model.

The investigator must be able to visualize the alignment and in effect the entire occurrence. The occurrence must also be re-constructed in order to develop a proper countermeasure and explain the occurrence and resource needs for the countermeasure to higher level executives in order to ascertain approvals and buy-in for the countermeasure.

The countermeasure must also be complete. It must cover all events and conditions and this many times involves specific chronological ordering. So, every root cause element has several noted conditions and events. The countermeasure must address all of these. In addressing all of these, it is optimal to have redundant safety controls in place. This is safety control reliability. If and when one fails another serves as a barrier.

It is very helpful for the investigator to produce an incident map of the occurrence. This is not a sketch of the scene. It is a chronological ordering of all events, concurring events, and conditions that shows progression of the entire occurrence.

The Butterfly technique is one such method that is superior to a mere listing of the root cause elements. Sometimes called the Bowtie Technique, after the software that utilizes this tool, it creates a visual alignment of the events and conditions present throughout an entire occurrence. It can also be sued to show probable events or conditions that could have resulted. The events and conditions are arranged inductively and deductively to show a cause and effect. Events narrow to one critical event that then produces subsequent results. The critical event can be different sometimes from investigator to investigator, but usually is the event that is a point of no return, or has few concurring conditions that are new to the occurrence. We will practice root cause analysis and incident mapping in this week’s lessons.

**Allocating Investigative Resources**

The amount of time and other resources required to conduct a full investigation necessitates that we investigate only certain occurrences. We typically call these critical incidents. These should be defined based upon the organization’s current needs. These needs should change as the safety culture matures. In other words, as we create safer environments, more time can be taken to investigate occurrences that were not as critical in the beginning. We may define a critical incident as an incident of personal injury, environmental spill, or near miss that has the potential to produce a serious injury or environmental spill. We may further define critical incident as property damage of a certain level or a security breach that had the potential for certain outcome. But the definition has elements. It begins with the type of event, and then is tied to results or potential results.

This is not to say that we do not assess and document all types or level of occurrences. The incident control log is the place for documenting the occurrence and a less detailed form can cover an assessment.

**Defining Occurrences and Incidents**

Safety professionals are present to preserve the human resource first. This includes environmental safety from the standpoint that the health of the environment is the health of the species. It is literally, save the planet, save the species philosophy. So we should categorize incident types based upon the human resource. It is important to understand that an incident is referring to a negative occurrence. Occurrence can also be positive. Incidents are truly divided into incidents with injury and incidents without injury.
<table>
<thead>
<tr>
<th>Occurrence:</th>
<th>Positive Outcome</th>
<th>Negative Outcome</th>
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<tbody>
<tr>
<td>Success Modes</td>
<td>Incident with Injury</td>
<td>Incident w/o Injury</td>
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We can now begin to label the incidents. Incidents with injury include recordable events, or injuries requiring recording on the OSHA 300 log, first aid events or injury events not meeting recording criteria, (these also include environmental spills or releases that incur human injury), criminal acts that result in injury, traffic crashes, and reportable injuries; like amputations, deaths, power press injuries. We try to cull out categories that would have special handling requirements such as reporting mandates. Criminal acts are uncovered by safety professionals and require involvement of law enforcement and prosecutors. Traffic crashes typically involvement law enforcement, may be recorded on other logs than the OSHA 300 log, and may involve insurance reports other than a worker’s compensation first report and follow up forms. Some injuries have special reports that must be filed to regulatory agencies, such as amputations involving power presses.

Incidents without injury can include near misses (which may be defined as a failure not producing an injury or damage), incidental spills (non reportable levels), spills and releases, security breaches, criminal acts, and property damage.

So events can be more specific to an incident. We are concentrating on negative outcome occurrences. But positive outcome occurrences can be defined and examined to identify the commonalities involved in an organization’s best performances. Projects, processes, machines, work stations, job tasks, etc that meet a set bar of performance can be studies to identify common elements that can become best management practices or parts of company standards. You will explore this more in the discussion board for the week.

**Investigation forms**

There are 5 sections to an investigation report form. These sections may be multiple pages depending on the specific situation. The investigator may prefer that specific pages be added or deleted from the report as needed and depending on the situation at hand. For example, there may be an additional page necessary for accidents that involve forklifts or for incidents involving a fire. The sections to be included are:

1. General incident information
2. Personal information of the involved persons
3. Narrative and scene drawings
4. Evidence dispositions
5. Cost Analysis
6. Cause Analysis/ Countermeasure

Once the investigation has produced a countermeasure the information may need to be shared with others in the organization like other plants, other jobsites, or the onsite personnel in order to prevent future occurrences. So, an executive summary form will have to be developed. It should include:
The facts of the incident
2. The causes of the incident
3. The countermeasures

The safety professional must be careful not to include information that would embarrass or alienate an involved employee. In many cases, the identity of the involved person will be known by many of the employees. Word can spread quickly between friends and co-workers, even if personal information is protected by the company. It is therefore advisable to always speak with the relevant employees and consult or explain the importance of sharing the story.

General Data

The general data consists of facts that do not change throughout the whole of the occurrence. Typical to this area are the incident control number, date of occurrence, date reported, location, time of occurrence, time of report, the reporting party, general conditions such as temperature, wind conditions, lighting, the identifier of the investigator or team, and other relevant data that the safety manager needs to collect in order to track information for reporting purposes. It is important to note that the time and date of occurrence and the time and date of the report and the identity of the reporting person are vital to measuring the accuracy of reporting and employee participation. Untimely reports and reports from a reporting person that is not involved are indicators of inaccuracy and negative participation.

Involved Persons

Several classes of involved persons exist in any occurrence. Most direct to the occurrence are classes like injured person, witness, in some cases in a workplace people are victims, in some cases they are suspects, they can be the person of focus (as we do not classify those committing mistakes as suspects), responders (both from outside agencies and internal), designer, owner, passenger, or merely referred to as employee.

An injured person is not always a victim. It is a slang that is not proper. In a workplace incident the injured person can have played a role in their own demise. While we do not play blame the victim, unsafe acts such as not following trained procedures, play a vital role in such occurrences. The guilt and fear of punishment combine to place a barrier between the objective truth and the investigator. We must uncover the objective truth in order to produce accurate countermeasures. Please review material from OSH 261 in reference to interviewing and using interrogation skills to gain the objective truth from all classes of involved persons. It is about taking pressures off or placing pressures on to gain the real story. Remember that injured persons also exhibit the signs of a victim and of a suspect.

Victims do not play a direct role in the result of the occurrence. They too must be handled in specific manners that overcome barriers to recall and truth.
Associates that are suspected of violating law or company procedure can be called persons of focus, or merely avoid the labeling if you are uncomfortable with the terms. But accountability must be present and handling this class of involved person also requires proper use of interview and interrogation skills.

The other classes of involved persons may play key roles in determining product liability, determining machine and PLC faults, or be critical in producing accurate countermeasures. The collection of the contact information for all involved persons is critical for accurate documentation. Cases once closed, can become relevant again years later. Investigators may not remember all parties months down the road after dealing with much more activity.

**Scene Sketch and Narrative**

The scene sketch, usually not to scale, is an important tool for documenting the arrangement of the scene upon arrival. Sketches can also show progression in some cases. For example, items that have moved during the occurrence could be shown as dotted figures and solid figures could represent location of final rest. This is a typical technique used for crashes involving vehicles and is very relevant with forklifts, parking lots crashes, or loading dock incidents.

The narrative is usually blank lines or space available for an essay of the findings. But consider directions or prompts that call for chronological events, and the answering of who, what, where, when, how, and why for each event. Speculation should be reserved to the end of the narrative and made clear as to the chain of indicators that allow the investigator to arrive at speculation.

**Evidence Disposition**

Evidence can be photos, sketches, statements, collected materials, and a wide array of items. It is important that the chain of custody be preserved. Evidence collected must be guaranteed to be in original, unchanged condition. Reports should indicate where the items are located and document any examination or custody of any other person.

A good example occurred a few months after changing slings used for hoisting steel coils at a facility in which I worked. The slings were designed with a Kevlar softener covering the areas of the sling where the steel coil would contact. These solved many ergonomic issues with using chain slings which had to be long and heavy.

While moving a 17000 pound coil, close to the ground, the sling broke. Upon investigation and reconstruction to include my own calculations of tension factors, and loads, it was noticed that the softener did not allow for full inspection of the sling, and that slices in the Kevlar were not readily noticeable until heavy loads could be applied directionally. The manufacturer sent two engineers to investigate the incident. Once they had documentation of the slings condition and the results of my investigation, they performed their own reconstruction and agreed with our findings. The sling was redesigned; the damage was paid for by the sling manufacturer. However, without documentation that the sling was in its original condition, the manufacturer would not have honored the product.
**Cost Analysis**

This section is vital to speaking in business terms. Using estimates based upon the Iceberg Model of costs are not credible to business managers. Actual costs must be presented. Therefore documenting damage and damage amounts, downtime, manhours involved in maintenance repairs, machine replacements, training, overtime, fines, medical costs, etc. allow for the safety manager to show hard numbers on the costs of incidents by type and more accurate set goals and objectives, calculate returns on investment, present budget requests, and even calculate the cost of safety on new processes or machines based upon numbers from similar machines, products, and processes that are in existence at the time of bidding on the new endeavor. The cost of safety is more that incidental production costs.

Not all of the information will be known early on, such as medical costs not being finalized. But the report can be updated, and a log for costs by type of incident can be kept if needed.

**Causal Analysis and Countermeasure Report**

The causal analysis should be more than a blank area asking for the root cause. Root cause should be broken down into the criteria for immediate cause and the factors of root cause for each event that was present in the whole incident. This form should likely be a page that can be added for each event identified and covered in the narrative. It might be best to number the events during the narrative section in order to match it to the causal analysis.

The countermeasure report should also be organized by event and then after documenting the elements of immediate cause and factors of root cause, identify counters and where they correlate to the elements of cause. This helps ensure that the countermeasure plan has considered the multiple causes present in the occurrence.

An incident map also should be included that identifies the events, conditions, and may even show counters once finalized. Examples of these documents can be found in course documents.

The root cause analysis, countermeasure report, and incident map all tie there relevant information back to the events. This allows for continuous improvement in the investigations initiative of the organization. Once the countermeasure is in place and subsequently evaluated for effectiveness, any issues of improvement can be examined back to the event and handling of the investigation at the point of event can be examined for accuracy. These implications are vital to safety success. Improved awareness and improved education and training of the investigators can be improved upon if needed, in accuracies can be reinvestigated as well for misinterpreting data or for mishandling human subjects. The investigator may have missed something and can now look at information differently.

Accurate investigations are key to your success as a safety professional from a credibility point of view. Upper level managers may grow skeptical of your countermeasure plans and require more and more selling of plans in order to allocate needed resources. Workers may also grow skeptical and not be as receptive to safety countermeasures, change, and overall procedures.