Article 9 – Considering 'acts' as critical controls and the challenge of their measurability

Welcome to the 9th article in the series. Article 8 overviewed the selection of critical controls, hopefully generating some thoughts about setting company or site objectives for moving to CCM, as well as considering the concept of 'indicativeness' as a potential critical control requirement.

This article will continue with the critical control selection topic by expanding on the measurability and indicativeness of control **acts** that might be potential critical controls. As mentioned previously, acts are one type of control along with objects and technological systems (see article 3 for definitions).

Feedback on article 8 suggested that climbing onto a large vehicle or structure using 3 points of contact is an act, and possibly a critical control, if the company or site defines their priority unwanted events as single fatality consequences or higher.

Many mining equipment manufacturers have done major work to reduce precarious climbing onto or off equipment, but the need remains for people to climb at heights with 3 points of contact.

So, can this act of climbing potentially be a critical control. Is it crucial, measurable and indicative?

A generic company or site Bowtie Analysis for a fall from some defined height (possibly 1.5 m or more) would likely result in '*climbing using 3 points of contact'* as a control act for many of the related threats and possibly the sole control for some. Thus, the act could be seen as crucial.

Initial consideration of the acts 'indicativeness' may also suggest its' value as a critical control. A crucial act that is common across many threats should be indicative. However, the other part of the critical control discussion is measurability.

To be indicative of the overall fatal fall risk the act must be measurable. How do we measure this crucial, indicative act to gauge the effectiveness of controls and thereby the acceptability of the company or site fall risk?

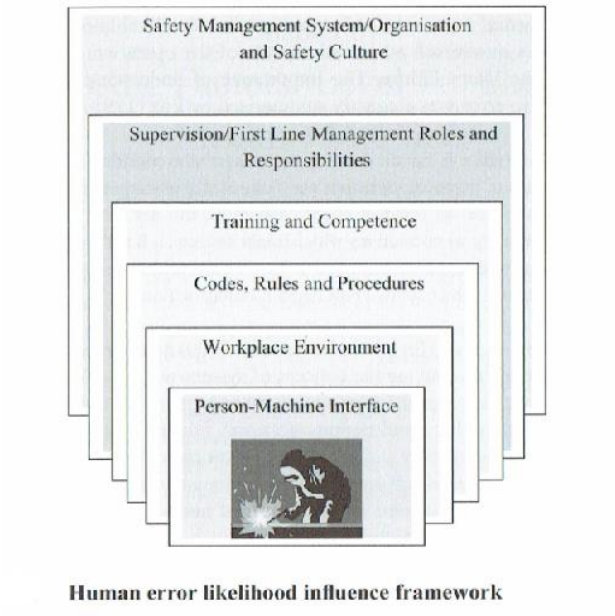
In article 8, the limitation of direct act observation was mentioned. In mining, it is often difficult to gather observation data on climbing. However, there may be related erosion factors and supporting activities that are possible measures of the likelihood that a person will use 3 points of contact when climbing.

An act has a life cycle like an object. The act must be defined, documented, transferred to the persons that are expected to act, and assessed to ensure the act is understood. Acts are also reinforced and modified to ensure they are up-to-date. Effectiveness of the steps in the act life cycle will affect the likelihood that the act will occur when required. This is how procedures, training and communication contribute to acts' effectiveness. As such, these aspects become part of an overall multifactorial 'algorithm' for the effectiveness of an act that can also include any available direct observation data.

In addition, and also mentioned in article 8, data related to the initiatives intended to reduce identified major erosion factors or to reinforce important supporting activities might also be part of an act algorithm.

The effectiveness of an act that is believed to be critical, like the *3 points of contact* example, can be established with adequate accuracy but the data used to verify the level of effectiveness will be sourced from multiple sources. Direct observation data about the act may only be part of the measure.

Another approach to considering act effectiveness contributors can be found in human error causation such as the work of Geoff Simpson and Tim Horberry as provided in the illustration below from their book "Understanding Human Error in Mine Safety" (2009).



Human error likelihood influence framework

Human error causation models such as the above provide possible prompts to help define potential erosion factors (negative influences) or supporting activities (positive influences) for a critical act. Any specific positive or negative influences on the desired act can be captured and discussed to determine the magnitude of their affect, and to identify any actions to reduce negative or reinforce positive influences.

For example, considering the Workplace Environment (assuming physical environment) related to an act such as '*3 points of contact climbing'*, erosion factors may be slippery climbing surfaces from equipment operation in muddy areas on site. Actions to provide methods to protect from mud or add grip to potentially slippery steps or holds could result from discussions. The success of these actions, such as the provision and maintenance of modifications, could be part of the measure for the *3 points of contact* act. In other words, act effectiveness is increased by successful reduction of erosion factors.

Related supporting activities may be initiatives to have clearly designated foot and handholds for climbing, where better engineering solutions are not feasible. This might be

an existing improvement programme at the site. Measuring its degree of application across all potential climbing locations may be an indicator of act effectiveness. In other words, it is more likely the *3 points of contact climbing* will occur if the climbing location has clear and optimal hand and foot holds.

These two potential measures of act effectiveness form part of the overall effectiveness measure. Remember, we are only measuring a few controls for a high priority event so the workload to define and operate, with the assistance of computer technology, our 'algorithms' should not be excessive.

Safety Management System / Organisation and Safety Culture consideration may also help identify erosion factors for acts such as production bonus systems that reward short cuts or an absence of feedback when a person is seen climbing incorrectly. Supporting activities may include engagement of personnel in positive learning from falling incidents. Measures can also be developed for both these examples.

If a potential critical act can be measured by direct observation data, life cycle contributors, erosion factors reduction initiatives, and/or supporting activities initiatives so that line managers feel comfortable that the final measure indicates the reliability of the act, as well as being indicative of the PUE (in this case a fatal fall), then the act can be a critical control.

Another comment on Article 8 suggested that acts are also involved in the effectiveness of objects ,and the object component of technological systems, in areas such as design and maintenance. A control that applies with or without human intervention must be designed, installed, maintained and modified by human acts.

The previous discussion about measuring critical act effectiveness could also apply to object life cycle acts that contribute to the object's effectiveness. Of course, doing a maintenance act to keep a hydraulic ladder functioning well, for example, may involve a different type of act to the *3 points of contact climbing* example.

The object related act might be '*ladder maintenance done as required*', noting that the fitters experience and knowledge, as well as the conditions that he or she encounters

determines the specific maintenance acts. The act is not as clearly specifiable as *3 points of contact climbing* which has implications to our measurement of effectiveness.

To explore types of acts, let's look at the various types of human performance (or acts) using Jens Rasmussen's theory. (see https://www.sintef.no/globalassets/project/hfc/documents/8-legacy-of-jens-rasmussen---andersen.pdf for a good summary).

- Skill based performance: – sensory-motor performance; – without conscious control, automated.
- Rule based performance: – stored procedures, induced by experience; – Taught problem solving/planning.
- Knowledge based performance: – in unfamiliar situations, explicit thinking; – develop plan, try it and see if it works.

The act of using *3 points of contact while climbing* is likely rule based since it has more conscious control than walking or climbing stairs which are skill based. The act of '*ladder maintenance done as required*' is knowledge based.

Measuring rule based acts has been discussed earlier in this article. Measuring knowledge based acts may require greater emphasis on measurement of factors such as knowledge and experience. It is probably a much more difficult to use direct observation of the maintenance act as an indicator that the critical control object is well maintained. Overall object effectiveness measures may be more aligned with maintenance plans and reports.

However, there may be also be valuable insights into measurable contributors resulting from discussing erosion factors and supporting activities for object design, maintenance and modification acts.

In summary, knowledge based acts may be potential critical controls or important contributors to a critical control such as an object. In both cases their measurability is more significantly based on factors that contribute to the act occurring rather than direct measurement of the act itself which is often easier for rules based acts. This will likely

increase the complexity of measurement, but both the related discussion and final measurement, and thereby verification process, definition should be a major contribution to the effectiveness of a knowledge based critical act.

Finally, the challenge is to define a good act ‘algorithm’ (set of measures and their weighting in the final total effectiveness measure) that establishes control effectiveness and is an indicator of overall event risk.

The next article, early in 2018, will discuss defining performance requirements for a selected critical control, followed by more discussion about measurement ‘algorithms’ in critical control verification and reporting.

Merry Christmas and have a safe, healthy and happy 2018.