

Human Performance Improvement

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The purpose of this presentation is to discuss a relatively new safety performance improvement strategy and that is “Human Performance Improvement”. The following specific topics will be addressed:

- The state of organizational safety maturity necessary for the implementation of human performance improvement strategies,
- Human performance improvement principles and some elements of implementation oriented management systems
- A discussion on the nature of mental processes, human error, error precursors and steps to minimize error.

Much of what is covered here is based on the work of Dr. James Reason and published in his books, *Human Error* and *Managing the Risks of Organizational Accidents*. It would appear that this topic has received relatively little discussion in mainstream safety circles. One purpose of this presentation is to build awareness and perhaps create more discussion on the topic in the safety community.

“Human performance improvement” (HPI) as discussed here refers to an element of a safety management strategy and safety management systems aimed at preventing undesirable occurrences or events in occupational endeavors. Some human performance principles are offered as are some comments on error prevention strategies and several important and relevant management systems.

HPI is most appropriate for, and indeed, is necessary in high reliability organizations. The definition of a high reliability organization used here is one in which the hazards and risks innate in operations are so significant, or the effects of incidents so catastrophic that the organization’s systems, procedures, standards and human performance, at all levels, must truly minimize the potential for an event or occurrence. Or put another way, an organization in which the safety management systems, procedures, standards and individual performance are sufficiently well developed and high that the probability of a serious organizational accident is de minimis. Examples of high hazard industries might include airlines, nuclear weapons research, nuclear power, some chemical processing industries, etc.

Successful implementation of HPI requires the prior achievement of a significant level of maturity in safety culture and safety management systems and technology in an organization. Consider maturity in safety systems from two viewpoints.

There are three elements which must be in place to achieve safety excellence.

First is management commitment. The level of maturity in leadership, culture and management systems. It is well known that the single most important criteria for achieving safety excellence is true senior management commitment, vision and drive. From this commitment stems the strength of safety leadership, safety culture and safety management systems that an organization puts in place. Investigations of major incidents, like Chernobyl, Bhopal, Three Mile Island and the Columbia Disaster, have all clearly demonstrated that management and management system failures are among the primary causes of these catastrophes.

Second is technology. If there isn't safe technology, facilities and equipment, the best management systems and behaviors are not enough. While there is always room for improvement, in many industries, available science, engineering and/or process technology has matured to the point that significant further improvement in safety will have to come from other areas. Not that the best available technology was always in use. Again, incidents like Three Mile Island and Bhopal reveal that contributing equipment and facility issues stemmed from the fact that the existing technology was well behind readily available, current standards. Thus, since the mid 1950's we have seen emphasis on process safety technology, and "design in safety".

The third level is human performance or behavior.

There is another model of organizational safety maturity that is important to this discussion. This can be thought of as the safety maturity of an individual, or a management team or an organization. Visualize a plot of injury frequency rate vs. maturity.

The lowest level of maturity mentioned here will be call "Reactive". This is where the organization, its management and staff clearly have a strong principle focus on production and profitability. They are "safety secondary" and only react to very serious incidents if and when they occur. Injury frequency rates are high that's basically OK with the organization.

The next level of maturity and the necessary first step toward improved safety performance is where leadership demonstrates a commitment to safety. Management is proactive about safety, puts in place policies, systems and standards which help improve performance. Management commitment and leadership energy go a long way to improve safety culture, safety management systems and performance. Leadership energy in the form of ensuring adequate worker training, adequate hazard analysis and controls, etc.

The next level is individual commitment. One of the products of leadership commitment is an appreciation for safety by individuals in an organization and development of individual safety capability, standards and responsibility. You don't get individual commitment without leadership commitment and energy. At this point, adding the commitment and competence of individuals to the energy of leadership produces further improvement in safety performance.

The next level is team commitment. This is where teams make commitments, there are team standards, problem solving, decision making and accountability.....and there is willingness to be a peer's keeper, to help one another avoid injury and to help each individual meet team standards. High levels of organizational trust must exist for It is well known that high performance teams can be extraordinarily effective. Now the energy of teams can be added to the energy of leadership and the individual and this produces an even further improvement in safety and operational performance.

It is this degree of maturity, somewhere between individual independence and team dynamics that human performance improvement strategies and systems can be put in place.

Consider the causes of occupational/industrial incidents. One historic view is that essentially all occupational injuries, illness and incidents can be considered as resulting from the unsafe acts of some person. This can be an act of omission or commission by management, technologists in design of facilities or equipment and/or workers. Studies done in high reliability organizations show that some 80 percent or more of all serious incidents are caused by some human failure or unsafe acts. The unsafe act is only the beginning of the story.

Human behavior is dramatically influenced by organizational values, norms, systems and standards. The same studies show that latent organizational weaknesses underlie about 70 percent of human factors failures. Latent organizational weaknesses are typically inadequate systems, standards or procedures that have been in place for some time. Typical examples are lack of a procedure, or a procedure developed for a work process that has changed and is no longer in use; inadequate or confusing instrumentation, lack of alarm system or its inadequate functionality, etc.

With that foundation laid, it is appropriate to discuss human performance improvement. The theme of human performance improvement is the ability to detect error likely situations and prevent incidents is dependent on management and workers understanding of human performance principles and processes.

The first principle has already been mentioned and that is individual's behavior is influenced by organizational values, norms, systems, standards and processes. To

improve human performance, it is necessary to identify and eliminate organizational weaknesses and continuously improve systems and standards.

The second principle is error likely situations are predictable and manageable. It is necessary to identify and prevent error likely situations and react to, correct and recover from active individual errors.

The third principle is that individuals achieve high levels of motivation and performance through coaching, encouragement and reinforcement from leaders, peers and subordinates in the organization. Continuous positive reinforcement of desirable work-specific behaviors is an enormously powerful tool in performance improvement.

Let's turn our attention now to a few elements of human mental processes and human error. Experts say the only difference between a successful outcome and human error is the quality of the mental process.

Underlying essentially all human knowledge and skill is what is known as schema. All our knowledge and skill base is stored in these schema, the plural for which is schemata, which have been compared to a nested filing system or perhaps like a set of Russian Matrushka or nested dolls. As an example of this nested filing system, consider an office. We have these filed under buildings, and a subset of building is an office building, and a subset of an office building is an office. And when we think of an office we think of desks and chairs and computers and filing cabinets, etc. And if we think of a desk, we think of a workspace and drawers, etc. This is our existing rationality. And we humans like to do mental processing by comparison to our existing knowledge base.

And this brings us to the first several elements of human error, those regarding schemata. One is "Imperfect Rationality" or the incompleteness or inaccuracy of the data stored in our schema; sometimes known as "Lack of Expertise". A second is similarity and frequency biases. Humans tend to give credence to solutions which are similar to the needed solution and to solutions that we use frequently. Third is "Imperfect Recall" or the inability to retrieve information from memory accurately or "Failure of Expertise" where information is inappropriately applied to the situation or problem at hand. While I will not go into detail here, the question to be addressed is, "Knowing these common forms of human error, what steps should be taken to minimize them?"

- There are three levels at which human perform and solve problems. They are as follows. The "Skill Level – where human performance is governed by well grooved preprogrammed instructions. This is automatic, practiced activity requiring little conscious processing.
- The Rule Based Level – where performance is governed by stored rules of the "if" (this situation), "then" (that response) kind. This is applicable to addressing well known problems where solutions are governed by well known rules.

- The third and last is the Knowledge Based Level – where novel problems are addressed by conscious, analytical processes using stored knowledge; this is difficult work.

Incident prevention techniques and systems vary by the type of work and mental process involved. For example a system and process for hazard identification and control would be markedly different for skill based activity as compared to knowledge based work.

The definition of human error used here will include all those situations where a planned sequence of activities fails to achieve its desired end. Errors are further divided by type into slips and lapses and mistakes. Slips are attentional slips in action. Lapses are typically memory lapses. Mistakes are either rule based mistakes where there is misapplication of a good rule or application of a bad rule, or knowledge based mistakes where knowledge is inadequate and a wrong conclusion is reached.

Violations are not errors. Violations are deliberate deviations from accepted or expected behavior. There are well known conditions under which violations tend to occur. It is not our purpose to deal with violations in-depth here.

Necessary conditions for slips to occur include a marked degree of attentional capture by something other than the job at hand. This can result from inattention, or mistimed attention or misdiagnosis of the position in a sequence of activities or a failure to detect a deviation from the expected or planned conditions. It can also result from an emotional distraction, medical or substance abuse condition.

Some steps which help with elimination of errors due to slips include the following:

- Limit distractions, interruptions and departures from routine
- Watch for and address “Human Nature” issues like stress, complacency, inadequate risk perception, personality conflicts, etc.
- Ensure that education and training are adequate
- Conduct practices to enhance personal skill with task; groove it in
- Clearly identify to workers those critical steps in a task to increase attention at key times
- Provide signals which cause people to check where they are in a process and verify next steps in a process

There are numerous necessary conditions for rule based errors. Many of these are familiar to the safety professional and real problems in industry. They include under the heading of “Application of Bad Rules”:

- inadequate hazard identification
- inadequate/inappropriate hazard controls
- inadequate work processes

- Inelegant, clumsy or overly restrictive rules

Some conditions for error based on misapplication of good rules include

- Misunderstanding or misdiagnosis of environmental conditions
- Failure to identify important changes
- Application of “Strong but Wrong” rule
- Information overload

Some steps necessary to eliminate rule based errors are as follows

- Develop high quality “Job Hazard Analyses” and “Safe Work Practices”. Ensure that they are useable and memorable to workers. Some necessary conditions are that they are brief, simplified, clear, illustrated, consistent
- Ensure that workers are well educated on the basis for the work procedure, and on the hazards and controls
- Ensure that workers practice to enhance personal skill with task
- Develop an awareness of the implications of changes in environmental conditions, technology and personnel
- Have workers practice “what-if” steps around corrective/emergency actions
- Clearly identify critical steps, high hazard points
- Walk-down JHA’s and safe work practices prior to implementing task. Using this technique have workers re-familiarize themselves with the task, asses situational factors and the adequacy of controls; teach workers the “Take Five” technique
- Minimize: time pressure, high workload/complexity and other issues which tax memory requirements.
- Also minimize simultaneous, multiple tasks and other issues which tax working memory.
- Minimize monotony
- Eliminate difficult controls/indicators

Some necessary conditions for knowledge based mistakes include:

- Incomplete or inadequate information, knowledge and model of the problem space
- Bias in problem identification or development of adequate solutions
 - Selective processing of task information – for example disregarding selective information regarding the task or the environment,
 - Incomplete/inadequate diagnosis – lack of investment of adequate energy or attention to completely diagnose the task or problem; jumping to conclusions

- “Confirmation” bias – this is a human nature weakness in a desire to be correct. There is a tendency to reconfirm an earlier conclusion despite the fact that additional information indicates the conclusion is not accurate.
- Oversimplifying causality
- “Complete Check Off” illusion – This is a situation where an individual feels confident that everything has been checked when in fact there are more issues that have to be identified and defined.

Some steps to which will help to avoid knowledge based errors include:

First and very importantly, use teams in problem solving. ***When in novel or unknown situations never rely upon one mind.*** Assure adequacy of breadth and depth of expertise.

Involve workers, first line supervisors, subject matter experts and managers in problem identification and problem solving. A divergence of skills and opinions need to be brought to bear and everyone’s opinion is important. It is frequent that the person who has an important answer for an unknown problem is a low level worker who is not completely comfortable speaking his/her mind in a group. And it is important that a wide segment of the line organization understand the thinking that went into problem solving.

Expend adequate time early in the process to get adequate information to completely understand the “problem”. Similar to a Process Safety Review, bring structured processes to ensure that adequate information is generated. Use “networking thinking” as opposed to linear thinking. Use “What-If” and other structured hazard analysis techniques to thoroughly examine the variables of and variability in technology, people and the environment.

Press to develop numerous wide-ranging solution hypotheses before settling on any one.

Test the adequacy of products of hypotheses.

Walk down solutions to verify their adequacy.

These are some dimension of human error and the corresponding steps to prevent the occurrence of safety incidents resulting from these errors. The lack of these in an organization are all precursors to errors and latent organizational weaknesses.

Let's focus now on some tools which will help us identify error precursors and latent organization weaknesses. Studies of the management systems used in a significant number of organizations with excellent safety performance show that there is a well known set of management systems which must be in place. These studies show there are four elements necessary to achieve operational and safety excellence. They are organizational culture, leadership commitment and energy, effective management systems and employee involvement and influence.

Here is a view of these management systems categorized by these four elements of excellence. These elements are necessary and sufficient to achieve excellence; each and every one is important in safety. However, one element of organizational culture and two management systems are of most direct interest to the topic.

The cultural element is culture of trust. It is an atmosphere of trust where workers are encouraged, even rewarded for reporting openly, for providing accurate and complete information on occurrences and incidents. And it is one where there are very clear, well understood lines that define acceptable and unacceptable behavior. A culture of trust is a prerequisite for a culture of a reporting organization. A culture of reporting is necessary to have a learning organization culture. A learning culture is necessary for a flexible culture and a flexible culture is a necessary prerequisite for a continuous improvement culture. Human performance improvement dynamics will only flourish in a culture or trust.

There are three systems for identifying organizational weaknesses and error prone situations: the management walkaround, incident investigation, and audits or self evaluations. The first two; management walkaround and incident investigation will be covered here briefly because of their relevance to human performance improvement.

A quote from the President of the utility operating TMI at the time of the incident will set the stage for this discussion. It is, "Probably one of the most significant learnings of the whole accident is the degree to which the inadequacies of the experience feedback loop.....significantly contributed to making us and the plant vulnerable to this accident."

The management walkaround is the single most important continuing management activity through which safety and operational leadership is established and maintained.

The purposes of the walkaround are:

- First of all to demonstrate management commitment to workers and their safety.
- Walkarounds are about observing work processes, observing people doing work, in a comprehensive and systematic way. This implies that there must be skill in making observations and in identifying hazards. It's about reaching judgments about the quality of safety in the organization.

- Walkarounds area taking the opportunity to have a positive, equilateral, collaborative interaction with workers aimed at developing relationships and trust. But they are also about achieving active thinking, on the part of both the workers and the observers, about safe behaviors, their connection to safe work, workplace standards, work related hazards, and error-prone situations.
- Another purpose is to bring “systems thinking” to the observation process to identify underlying causes of actions, analyze adequacy of standards and procedures. And based on this analysis to identify organizational weaknesses and systems improvement needs.
- And finally, together with workers, using the information/data from observations to drive work process, systems and performance improvement.

There is no more direct or powerful way of driving performance improvement than a well implemented Management Walkaround system.

Incident investigation is the final management system to be covered. The very occurrence of incidents demonstrates that systems, standards, work processes are inadequate. Incidents without serious potential are “free” learning opportunities; opportunities to identify organizational weaknesses and error prone situations and to correct them. If an organization does not learn from incidents, it is doomed to repeat them until they have a catastrophic outcome.

Incident investigation is a line management responsibility. The only legitimate purpose of incident investigation is to identify steps necessary to prevent recurrence of the incident. This is done by defining what happened, identifying the underlying causes and system improvement necessary to prevent recurrence and finally to communicate the lessons learned as broadly as applicable.

The way incident investigations are handled has a major impact on organizational morale, openness and trust and, in turn, on the capability to have the level of teamwork necessary to implement human performance improvement strategies. Investigations must be done in a way that separates the investigation from any disciplinary action.

There is much to be said in human error technology about incident investigation.

One interesting concept is that there are two elements of an action: intention and behavior. Examining intention and behavior can be very helpful in incident investigation. This lead James Reason to the creation of a “Culpability Matrix”. Understanding and utilizing the culpability matrix can be very helpful as a tool in incident investigation and as a communication process with the workforce.

I'll close with another key thought from human performance improvement and that is that human error is simply a symptom of troubles deeper within the management system. Sidney Dekker, author of *Field Guide to Human Error Investigations*, offers that one important viewpoint to bring to incident investigation is to determine why people's assessments and actions made sense to them at the time of the incident. Or said another way, what is it about the organizations systems, processes and standards which permitted or facilitated the intention, behavior and action?

The purpose of this paper is to stimulate thought on the questions. Does human performance and human error technology have significant elements to add to occupational safety and health? Has the safety profession adequately integrated human performance improvement strategies into their organizations safety management system?