Factors Affecting Error and Event Probabilities

Factors Influencing Human Error Rates

We know that the perfect human does not exist. That is human fallibility. What happens when you place the fallible human in an imperfect work environment, executing imperfect work processes, under extreme conditions, without the proper support? You get fallibility[2] or worse! The internal and external factors that aggravate human fallibility introduce the concept of vulnerability.

Humans are vulnerable to their internal make up as well as external workplace factors. These factors are referred to in literature as performance shaping factors, error-precursors, error forcing contexts, and so on. Our ability to perform in the presence of these conditions, when they are negative, suffers and error probabilities escalate. Much of the time, these factors are neither good or bad, they are a part of our work reality that must be managed.

The organization focused on event prevention constantly evaluates its task structure and work environment to optimize the conditions in which its employees perform. Component labeling, technical instruction accuracy, work planning, scheduling, reward systems, and culture are but a few examples of these conditions. Management of task and environment, primarily external concerns, are the simpler of the performance shapers to identify and deal with.

The other half of the human performance equation is the internal make up of the human involved in task execution. Human interaction with the task at hand is primarily driven by three components. The human's knowledge, risk perception, and situational awareness. Knowledge level is both fundamental knowledge and experience. Of the three, organizations' hold a greater ability to influence this component. Training programs, lessons learned from reported events, and the use of industry operating experience applied in a continuing initiative, establish a minimum acceptable knowledge level and enable the development of better mental models of operation over time.

Situational awareness and risk perception is largely dependent on familiarity with the task at hand and prior performance success. Perception of risk will decrease as proficiency and successes increase. Similarly, as the experienced performer becomes adept at monitoring his work situation he becomes willing to bear greater risks. These elements of human nature feed on each other. Left unchecked, the whole organization's acceptable risk burden increases. What was once a hazardous venture is now the routine.

Internal and external performance shapers exist for the human as the Yin and Yang. They are a constant reality in the workplace, competing for the human's margin against committing an error. When the balance of "Yin and Yang" is not maintained the human is "error-likely" or "at risk." The safest and most profitable organizations balance these factors as a minimum and strive to optimize whenever possible, increasing the human's resiliency to error. Figure 1 illustrates a model of this concept.
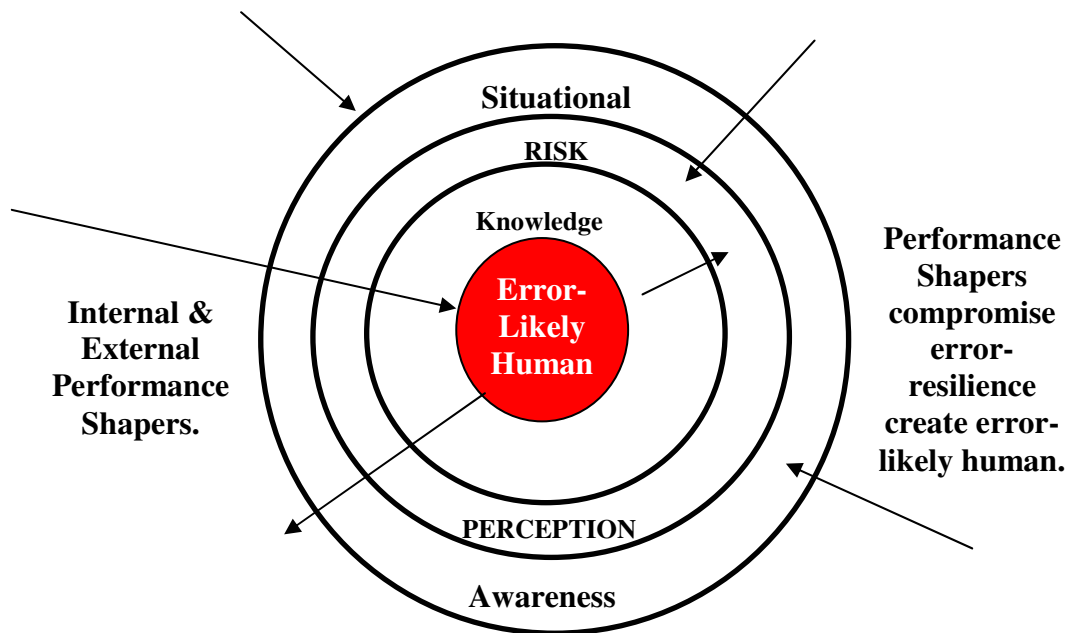
Figure 1

Discussion of Model

The model proposes three components that make human task performers resilient to error: situational awareness, risk perception, and knowledge.

Situational awareness (SA) from a performer's point of view is the ability to maintain sufficient attention to the task at hand to prevent the skill-based slip or lapse. It also cues the performer to transition to a rule-based or knowledge-based performance mode as the situation changes. For the purposes of discussing this model, SA may be defined as the performer's ability to couple to the task.

SA is attacked to a large degree by external factors, assuming the performer is fit for duty. Visual performance shapers, followed by auditory input to a far lessor degree, will compromise SA. Equipment labeling, warning signs, and instrumentation designed to assist coupling of performer to task reduce error probabilities stemming from lost SA. Other preventative measures include minimizing distraction, or teaching the performer how to deal with distraction, thus reducing divided attention, sequence interruption, and scanning errors.

Risk perception, the second component, acts as a filter during task performance. Risk perception is affected by internal and external factors, but is usually an internal mechanism. Performance shapers of risk perception are often categorized as complacency, overconfidence, can-do attitudes, and Pollyanna effects. Inaccurate risk perceptions serve to keep the performer at a skill-based level when they should be taking a more deliberate, rule-based or knowledge-based, approaches to the task. The culture of the organization is a determinant in the performer's risk perception. The organization that

has a production over emphasis, and a high acceptable risk burden, supports the performer's internalization that the risky situation is situation normal.

Knowledge, comprised of fundamental knowledge and experience, is the component closest to the performer. Our own internal biases, inadequate understanding of the system/process and new or infrequent performance conditions breach this component.

The premise of the model is that when any or all of these components are diminished, or breached, the task performer is more like to error. The organization intent on event prevention manages performance conditions to maintain these factors as robust as possible.

Factors Increasing the Probability of an Event

When the human errors during the execution of a task, more often than not nothing devastating occurs. This fortunate happenstance is dependent on the state the system, or place in the process, when the error is made. Vulnerability is valid for the system as well as the human interacting with the system.

System design determines specific system vulnerabilities. Vulnerability is minimized by the well-known concept of defense in depth. Defense in depth allows the system to suffer equipment casualties and still operate satisfactorily or be returned to a safe state. The system is most vulnerable when the task defeats or decreases defense in depth.

Probabilistic Risk Assessment (PRA) is a method used to determine system vulnerability due to equipment that is not in service. This method of establishing actual system risk suffers because it does not account for human caused challenges to the system's design during human interaction with the vulnerable system. Reported maintenance and operations induced failures in the nuclear power, fossil power, and aviation industries indicate that human error is a far larger risk to a vulnerable system than equipment failure.

Conclusions

The overall probability that an event will occur during task performance is a combination of system and human vulnerabilities. Organizational risk is better determined by assessing system vulnerabilities at critical performance steps, added to the error vulnerability of the human accomplishing those steps. Analyzing task performance, using this method, enables the organization to place defenses where they will provide an actual benefit, rather than using a coverall approach most organizations use at present.

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