Transactions of the Korean Nuclear Society 2018 Fall Meeting
Yeosu Expo-Convention Center, Korea, Oct. 24~26, 2018

An Introduction of Human Error 3.0 Concept to Cope with the Safety Culture Issue in Nuclear

Yong-Hee Lee
Nuclear ICT Research Division, Korea Atomic Energy Research Institute (KAERI)
Daedeok-daero 989-111, Daejon, Korea, 34050
✉ yhlee@kaeri.re.kr

1. Background : Human Error and Safety Culture, Two Topics in Nuclear

After Fukushima accident, the public parties have revealed strong reluctances to the many nuclear applications as well as power plants. The public confidence to the nuclear technology has been demolished since the accident shows the intrinsic limitation to maintain the safety through technological achievements up to now in nuclear. One of the intrinsic limitations is the safety culture, which has been a hard-to-overcome safety theme notorious in various fields.

Safety culture issue had been raised, however, a critical safety task after Chernobyl accident that happened in USSR more than a few decades ago. The safety culture issue at that time included a moral aspect and potential defects within the design and operational philosophy of USSR. Nobody in front of Fukushima accident can stand that any technological effort can overcome the safety culture issue though various efforts had already been proposed and sincerely conducted by utilities, international/local /regulatory agencies and many research bodies.

Safety culture issue is prevailing as a common cause of those nuclear events after Fukushima accident. Many studies have been revisited the human errors during the investigations of the safety culture related events in nuclear(2012 IAEA). Human errors such as violations(as a EOC) and negligences(as a EOO) of an operator and/or a team/organization are closely related to moral aspect and the confidence to nuclear. Sometimes human error and safety culture are described as a root cause to each other in nuclear events.

However, it requires a quite different perspective to understand the problems of the event and to figure out any retrospective countermeasures to the event practically. In this paper a new concept of human error 3.0 is proposed to avoid the confusion with this inter-relationship and to cope with safety culture issue in more practical manner for restoring, especially, the confidence degradation.

2. A Critique to Safety Culture Issues on Human Error Events in Nuclear

2.1 Arguments on the Safety Culture as a Cause of Human Error Events in Nuclear

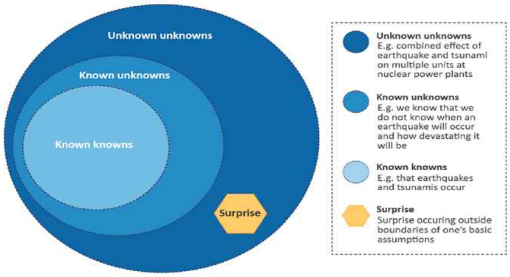
Nowadays the safety culture has become highlighted as one of the critical and/or root causes of human error events in nuclear systems. However, there might be somewhat suspicious to raise the safety culture as a cause of human errors. A few arguments are described on those human error studies concluded into the causality of safety culture. (2015, 2018 Lee)

Firstly, safety culture is crucial but self-evident to human errors. It might be trivial to describe the safety culture in defects within the event structure. Secondly, the term of safety culture is a too broad and vague to understand the concrete mechanism of human errors and to specify practical countermeasures. Additionally the resolution of safety culture problem is notorious and sometimes beyond the safety engineering scope in practice. It requires a multidisciplinary perspective over the traditional safety concept. Practically the cause of safety culture cannot mean any countermeasure that is implementable with engineering, and make the responsibility avoidable (so-called *Attribution Phenomena*).

2.2 Arguments on the Fukushima Lessons

IAEA published huge amount of reports on Fukuchima(2015 IAEA). Human factors studies raises many lessons in terms of safety culture. However, the a few words found in conclusive paragraphs push the nuclear into the *fundamental surprise* with unknown tasks on unknown future.

Human factors in nuclear is now demanding up to the level of "*Prepare the Unpreparedness*". Safety culture issue never escape human errors that could mean the crew responsibility of the unpreparedness to unknown future challenges. However, it might be doubtful to conclude that human error and/or safety culture is a cause of the Fukushima accident and countermeasure is to remove the responsible defects from the system.



3. Human Error 3.0 Perspective and A Revisit Study to Safety Culture Events

3.1 Different Perspectives on Human Errors

Human factors engineering was motivated by the human error issues experienced from the early era of industrial revolution. It has provided the fundamental basis and the key concepts to resolve them and enhance the human performance to support the ultimate effectiveness of an industrial systems. Three different perspectives of human errors can be identified according to the progress of human factors engineering(2015, Lee).

Many human errors has happened in repetitive tasks during the first era of the industrial revolution. Time and motion study has provided good basis to resolve them. The concept of human error 1.0 applied to time and motion studies has been mainly focused to the capability and limitations of task workers. Countermeasures enhancing the human capability can be beneficial to resolve most of human error events through education/training over the required task.

And some further errors has happened due to the mismatch between the human and machine rather than the limitation of human capability, especially during/after the World War periods. This has continued to the field of many human-machine systems such as automobiles, air/aero-crafts, military machines, process setups, computer systems, and smart-phones recently. Human error 2.0 has been mainly focused to the compatibility of the interfaces and surroundings of human in a system rather than human itself. Investigation process such as ACRS and HPES should include all possible defects of elements within a system and their causal mechanisms that happened into an event. Counter-measures suggested to prevent the human errors 2.0 could have been designs, modifications/enhancements of the interfaces/interactions in terms of HCI, HMI/HSI, MMIS, and UI/UX recently.

There might not be any specific causes of a human error event (refer to Dr. Perrow's 'Normal Accident' paradigm), however, and sometimes it could not be possible to specify any isolated factor as a cause of the event. A different perspective on human errors is required in a new term of human error 3.0. The behavior and mechanism of a system itself sometimes turns out to be fragile, especially in an unexpected situation, rather than any specific defect of a component in a system. It might not be possible nor be practical to specify some isolated factors as critical causes and remove them from the system in the disastrous accident such as Fukushima accident. The all factors in a high-reliability large complex system should be tightly coupled each other.

3.2 A Revisit to Human Errors in Trip Cases

It might be a kind of time and resource consuming to conduct human error investigation based on human error 2.0. The investigation of all elements and their possible defects, and their causal mechanisms is exhaustive in combinatorial manner. According to the new concept of human error 3.0, the practical countermeasures to the human error events might be more crucial rather than any scientific mechanism and real causes of human errors. Surrogate variables(2010, Lee and Shin) can be selected to interrupt the accident changes among the influencing factors in case with those information on the system behaviors .

Human error 3.0 concept was introduced to investigate the 27 trip cases that happened after 2000 in Korean NPPs(2007, KAERI). Efforts has not been put on the causes of events, but put on the possible/plausible countermeasures that could be effective to prevent the recurrence of the similar kinds of events though they might not be the causes of the events. The result of revisit study shows a set of lessons learned that is very different from the real causality of the events, but very informative with about ten-times of countermeasures selectable by practitioners and decision makers to improve safety culture.

4. Conclusion

The new perspective of human error 3.0 proposed might be helpful to understand the safety culture issue included in human error events and to obtain countermeasures to the safety culture problem in more practical manner.

5. References

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