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Understanding Nuclear Safety Culture: A Systemic Approach

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Synopsis

Paper Background: Fukushima accident was a systemic failure (Report by Director General IAEA on the Fukushima Daiichi Accident). Systemic failure is a failure at system level unlike the currently understood notion which regards it as the failure of component/equipment. Systemic failures are due to the interdependence, complexity and unpredictability within systems and that is why these systems are called complex adaptive systems (CAS), in which “attractors” play an important role. If we want to understand the systemic failures we need to understand CAS and the role of these “attractors”.

Paper’s Objectives

The intent of this paper is to identify some typical attractors (including stakeholders) and their role within complex adaptive system. Attractors can be stakeholders, individuals, processes, rules and regulations, SOPs etc. towards which other agents/individuals are attracted. This paper will try to identify “attractors” in nuclear safety culture and influence of their assumptions on safety culture behavior by taking examples from nuclear industry in Pakistan. For example, if nuclear regulator is an attractor within nuclear safety culture CAS then how basic assumptions of nuclear plant operators and shift in-charges about “regulator” affect their own safety behavior?

Complex Adaptive Systems and Attractors

According to complexity theory, [Gell-Mann, 1994, Senders, 1998, Antonacopoulou, 2005, Stacey, 1995, Reiman 2014, Chan, 2001] all social systems, including “safety culture”, are CAS. CAS are nonlinear with increasing number of independent heterogeneous agents who constantly interact in unpredictable and interdependent ways. CAS are dynamic and self-organizing systems, where changes take place system wide (like a butterfly-effect) and new structures and shapes emerge and disappear (“Perking” by Senders, 1998). The agents within CAS adapt to new information and actions of other agents. Attractor shape self-organizing, co-evolution behavior and new emergence within systems and help us predict system behavior. To understand CAS, we need pattern recognition skills to identify opportunities in evolving system by conducting systemic analysis of all possible attractors.

Safety Culture as Complex Adaptive System

Safety Culture is a complex adaptive system; mix of individuals, organizations and technological systems. When the system is complex, there is higher internal friction, unpredictability and unknown risks (Kauffman, 1993). Moreover, peoples’ perceptions and understanding of their situation continuously evolve and lead them to adopt new behavior. Hence, there is fundamental difference between fixed law of physics and dynamic patterns within CAS. We cannot study CAS by dividing it into smaller parts or through traditional systematic and analytical thinking. CAS can only be understood when seen as a whole with complex interdependences and interactions i.e. systemic approach.

Systemic Analysis of Possible Attractors in Nuclear Safety Culture in Pakistan

There could be a number of attractors within nuclear safety culture CAS. The analysis of basic assumptions

about safety culture of different attractors can help us see the safety culture from a systemic approach. Following human, organizational and technological attractors were identified within Pakistan's nuclear organizations:

1. Plant Management
2. Operator Top Leadership
3. National Nuclear Authority
4. Nuclear Regulator
5. Integrated Management System, SOPs etc.
6. Accident reporting
7. Regular Operational Meetings
8. Stories of Seniors
9. Training and Mentorship
10. Learning and adaptation from safety exercises and IAEA reports
11. HR Systems
12. Public and Society

Attractors build new assumptions and behaviors and change the old ones within safety culture. Assumptions of one attractor about "safety culture" influence behavior of other attractor at systemic level.

Analysis of Attractors' Assumptions and Behaviors

Following are few desirable and not-so-desirable assumptions of plant-operators about nuclear regulator

1. Regulator will accept what we report to them as they are part of national nuclear system
2. No need to report this event to regulator
3. We always report all events and assessments results to regulator since our regulator is very knowledgeable about operations
4. Do not expect strict regulatory actions in case of serious violation
5. Regulator is weak and dictated by Authority
6. Regulator is captured
7. Regulator lacks competence
8. Regulator lacks legal basis

Desirable Safety Culture Assumption, Behavior and Consequence

Assumption: We always report all events and assessments results to regulator since our regulator is very knowledgeable about plant operations

Behavior: Open, trustworthy communication between plant operators and regulators

Consequence: Regulator is in better position to conduct safety oversight

Not-so-desirable Safety Culture Assumption, Behavior and Consequence

Assumption: Regulator will accept what we report to them they are part of national nuclear system

Behavior: Lack of respect for regulatory oversight among operators

Consequence: Poor and ineffective regulatory oversight and high risk of nuclear accidents

It is very important to have desirable, shared and common basic assumptions about nuclear safety culture for all attractors. Conflicting and not-so-desirable basic assumptions among attractors within nuclear safety culture system will increase the safety risks and unpredictability within this CAS.

Country or International Agency

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