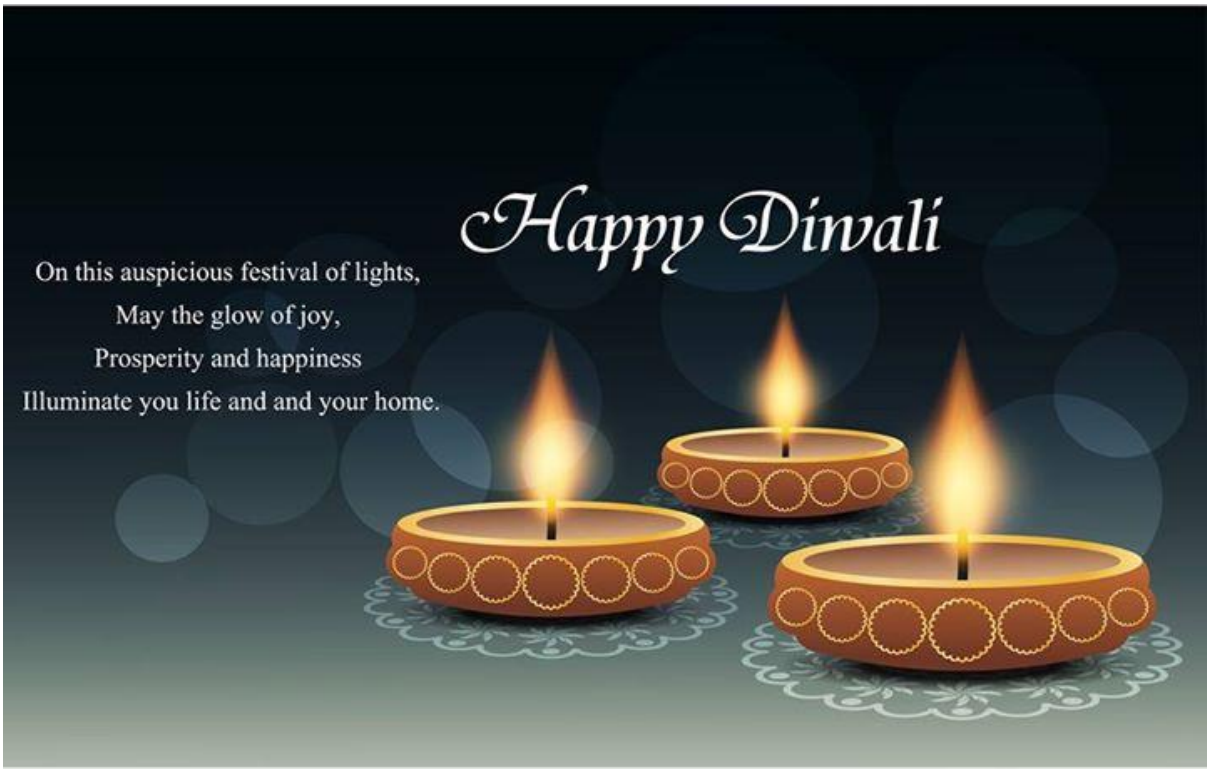
SafetyInfo

Page 1 of 5

Vol. No. 07 Issue No. 21 *Fortnightly, Free soft copy* **1st November 2016**



Resilience Engineering & The Fifth age of Safety

Dr (Capt) Suresh Bhardwaj, *fics,fni,fcmmi*
Resident Director & Principal, MASSA Maritime Academy, Chennai.

The increasing complexity in highly technological systems such as aviation, maritime, air traffic control, telecommunications, nuclear power plants, space missions, chemical and petroleum industry, and healthcare and patient safety is leading to potentially disastrous failure modes and new kinds of safety issues. Traditional accident modelling approaches are not adequate to analyse accidents that occur in modern socio-technical systems, where accident causation is not the result of an individual component failure or human error." (Qureshi, 2007).

Safety science today views serious accidents not as the result of individual acts of carelessness or mistakes; rather they result from a confluence of influences that emerge over time to combine in unexpected combinations enabling dangerous alignments sometimes catastrophically (Turner and Pidgeon, 1997).

The accidents that stimulated the new safety science are now indelibly etched in the history of safety: Challenger and Columbia, Three Mile Island, Chernobyl, Bophal, Davis Besse, Piper-Alpha, Texas City, and Deepwater Horizon. The list is long. These accidents have introduced new concepts and new vocabulary: normal accidents, systems accidents, practical drift, normal deviance, latent pathogens, organizational factors, and safety culture. As explained by Roger Boisjoly in an article after the 1986 Challenger accident: "*It is no* *longer the individual that is the locus of power and responsibility, but public and private institutions. Thus, it would seem, it is no longer the character and virtues of individuals that determine the standards of moral conduct, it is the policies and structures of the institutional settings within which they live and work.*" (Ermann and Lundman, 2002).

Systemic Accident Models

New approaches to accident modelling adopt a systemic view which considers the performance of the system as a whole. In systemic models, an accident occurs when several causal factors (such as human, technical and environmental) exist coincidentally in a specific time and space (Hollnagel 2004). Systemic models view accidents as emergent phenomena, which arises due to the complex interactions between system components that may lead to degradation of system performance, or result in an accident.

Systemic models have their roots in systems theory. In a systems theory approach to modelling, systems are considered as comprising interacting components which maintain equilibrium through feedback loops of information and control. A system is not regarded as a static design, but as a dynamic process that is continually adapting to achieve its objectives and react to changes in itself and its environment. The system design should enforce constraints on its behaviour for safe operation, and must adapt to dynamic changes to maintain safety. Accidents are treated as the result of flawed processes involving interactions among people, social and organizational structures, engineering activities, and physical and software system components (Leveson 2004).

The perspective of Resilience Engineering

This perspective counters the historical deterministic view that safety is an inherent property of well-designed technology and reveals how technology is nested in complex interrelationships of social, organizational, and human factors. Viewing safety though the lens of complexity theory illuminates an understanding that it is the ability of people in organizations to adapt to the unexpected that produces resilient systems, systems in which safety is continually created by human expertise and innovation under circumstances not foreseen or foreseeable by technology designers.

Resilience Engineering is defined as 'The intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under expected and unexpected conditions.'

For Resilience Engineering, 'failure' is the result of the adaptations necessary to cope with the complexity of the real world, rather than a breakdown or malfunction. The performance of individuals and organizations must continually adjust to current conditions and, because resources and time are finite, such adjustments are always approximate. This definitive new approach explores this groundbreaking new development in safety and risk management, where 'success' is based on the ability of organizations, groups and individuals to anticipate the changing shape of risk before failures and harm occur.

Erik Hollnagel, a pioneer of the Resilience Engineering perspective, has explained that accident investigation and risk assessment models focus on what goes wrong and the elimination of "error." While this principle may work with machines, it does not work with humans. Variability in human performance is inevitable, even in the same tasks we repeat every day. According to Hollnagel, our need to identify a cause for any accident has coloured all risk assessment thinking. Only simple technology and simple accidents may be said to be "caused." For complex systems and complex accidents we don't "find" causes; we "create" them. This is a social process which changes over time just as thinking and society change.

Hollnagel and other resilience thinking proponents see the challenge not as finding cause. The challenge is to explain why most of the time we do things right and to use this knowledge to shift accident investigation and prevention thinking away from cause identification to focus on understanding and supporting human creativity and learning and performance variability. In other words, understanding how we succeed gains us more than striving to recreate an unknowable history and prescribing fixes to only partially understood failures (Hollnagel, Woods and Leveson, 2006).

It has been suggested that we are living in the fifth age of safety. The first was a technical age, the second a systems age, and the third a culture age. Metaphorically, the first may be characterized by engineering, the second by cybernetics and systems thinking, and the third by psychology and sociology. The fourth age, the "integration age," builds on the first three ages not abandoning them but blending them into a trans-disciplinary socio-technical paradigm, thus prompting more complex perspectives to develop and evolve. The fifth age is an "adaptive age." It does not displace the former, but rather transcends the other ages by introducing the notion of complex adaptive systems in which the roles of expertise, professional practice, and naturalistic observation attain primacy in resolving the duality of "work-as-imagined" versus "work as done." (Borys, Else & Leggett, 2009)

The adaptive age embraces adaptive cultures and resilience engineering and requires a change in perspective from human variability as a liability and in need of control, to human variability as an asset and important for safety. Embracing variability as an asset challenges the comfort of management. However, the gap between work as imagined and work as performed and the failure of OHS management systems and safety rules to adequately control risk mean that a new perspective is required.

At present, we see mere glimpses of the implications of the adaptive age on how we think about "accident investigation." How we may view accidents though fourth Age lens is somewhat clearer. Though still myopic, we do have examples of fourth age investigation reports beginning with the Challenger Accident. Dianne Vaughn wrote, "*The Challenger disaster was an accident, the result of a mistake. What is important to remember from this case is not that individuals in organizations make mistakes, but that mistakes themselves are socially organized and systematically produced. Contradicting the rational choice theory behind the hypothesis of managers as amoral calculators, the tragedy had systemic origins that transcended individuals, organization, time and geography. Its sources were neither extraordinary nor necessary peculiar to NASA, as the amoral calculator hypothesis would lead us to believe. Instead, its origins were in routine and taken for granted aspects of organizational life that created a way of seeing that was simultaneously a way of not seeing.*" (Vaughan, 1996).

The U.S. Chemical Safety Board enhanced our fourth age vision by several diopters in its report on the British Petroleum Texas City Refinery accident. Organizational factors, human factors and safety culture were integrated to suggest new relationships that contributed to the nation's most serious refinery accident. More recent investigations of the Deepwater Horizon catastrophe was similarly inspired by the BP Texas City investigation.

This latest versions of approach to accident investigation and organizational learning is by no means presented as an exemplar of fifth nor even fourth age safety theory. But it is developed with awareness of the lessons of recent major accident investigations and what has been learned in safety science since the early 1990s. Still grounded in the fundamentals of sound engineering and technical knowledge, this version does follow the fundamental recognition that technical factors alone explain little about accidents. While full understanding of the technology as designed is necessary, understanding the deterministic behaviour of technology failure offers little to no understanding about the probabilistic, even chaotic interrelationships of people, organization and social environmental factors.

Classic investigation tools and enhanced versions of tools would be of use to investigators in making sense of the events and factors. However, further tools in the Resilience Engineering framework may be used to explore unexpected occurrences, so called “information rich, low consequence, no consequence events”, to perform organizational diagnostics to better understand the “work-as-imagined” versus “work-as-performed” dichotomy and thus maintain reliable and resilient operations (Johnson, 1973).

The most important contribution of this new version is the reminder that tools are only mechanisms for collecting and organizing data. More important is the framework; the theory derived from research and practice, that is used for interpreting the data.

This version thus challenges future investigators to apply analytical tools and sound technical judgment within a framework of contemporary safety science and organizational theory.

BIBLIOGRAPHY

Borys, D., Else,D., and Leggett, S.(2009) The Fifth Age of Safety: the Adaptive Age, *Journal of Health & Safety Research & Practice,* 1-1.

Ermann, D.M., & Lundman, R.J., (2002) *Corporate and Governmental Deviance: Problems of OB in Contemporary Society* (6th ed.) New York, Oxford University Press. ISBN 0-19-513529-6

Hollnagel, E., Woods, D.D. & Leveson, N.C. (2006). *Resilience engineering: Concepts and percepts.* Aldershot, UK: Ashgate.

Hollnagel, E. (2004) *Barriers and Accident Prevention,* Aldershot, UK: Ashgate.
Johnson, W.G., (1973). *The Management Oversight and Risk Tree (MORT)*,SAN-821-2, U.S. Government Printing Office.

Leveson, N. (2004). A New Accident Model for Engineering Safer Systems, *Safety Science*, 42(4): 237- 270.

Qureshi, Z.H. (2007) *A Review of Accident Modelling Approaches for Complex Socio-Technical Systems,* Defence and Systems Institute, University of South Australia.

Turner, B. and Pidgeon, N.F. (1997) *Man-Made Disasters: the Failure of Foresight*. Butterworth-Heinemann, London.

Vaughan, D. (1996). *The Challenger Launch Decision, Risky Technology, Culture, and Deviance at NASA*; University of Chicago Press, Chap X, p. 394

We are indeed grateful to Capt. S. Bhardwaj for contributing this article to this issue of Safety Info."

Readers may please note that D. L. Shah Trust brings out two e-journals on a fortnightly basis. These are mailed to those persons or institutions who are desirous of receiving them:

These two e-journals are:

1. Safety Info

2. Quality Info

If you or your friends or colleagues wish to receive these journals, you may send us an email requesting for the same. There is no charge for these journals. Our e-mail address is:

dlshahtrust@yahoo.co.in

or

haritaneja@hotmail.com

or

dlshahtrust@gmail.com

You can also access these journals on our website: www.dlshahtrust.org

Published by : D. L. Shah Trust, Bell Building, 2nd Floor, Sir P. M. Road Mumbai 400001 email: dlshahtrust@yahoo.co.in Ph: 022-2283 8890 Subscription: Free on request (soft copy only)	**Edited by : Hari K Taneja, Trustee, D. L. Shah Trust email: dlshahtrust@gmail.com TeleFax:022-230 9609 Phone: 022-2309 6529 Subscription: Free on request (soft copy only)**