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SRESA *Newsletter*

Issue-4-2022 Oct-Dec.

A quarterly publication of Society for Reliability and Safety [Reg. No. 3141/2010/G.B.B.S.D.], Mumbai

SRESA Mission

SRESA launched its new activity – 'SRESA Distinguished Speaker Talk Series' (SDST). Which is a monthly event. So far, three talk from renowned experts have been organized starting from Dr Oliver Straeter, CALCE, UMD, USA, Prof. Uday Kumar, LTU, Sweden and the recent one from Prof. J. Knezevic, MERCE Academy, UK. The experience has generally been good given the fact that most of the speakers readily agreed to share their experience. We at SRESA feel these talks by eminent personality will enhance risk and reliability consciousness in India.

From the President's Desk ....

In India, the October to December period is marked by festivities, be it Ganesh Chaturthi, Navaratri, Dussehra, Diwali, Christmas, etc., and this showcases Indian ethos, culture, and general consciousness mainly the spiritual component of life. I take this opportunity to wish you all a peaceful and happy times ahead in all your ventures and endeavours.

The recent couple of months also underlines initiation or transition from *'Azadi ka Amrit Mahostav'* that was being celebrated to mark the 75 years of Independence to the next phase – *'Amrit Kal'.* Amrit Kaal is a Vedic astrology term which signifies the perfect time to start a new venture. This is the time when bigger success can be achieved with proper efforts. For SRESA community it means to fulfil the aspirations of the nation in the area of risk and reliability and innovate, develop, and deploy the new and advanced tools, methods and solution that caters to national interest while becoming world leader in the subject field.

Even though SRESA has been working on many fronts and become an important umbrella organization at national, and international level, there are some areas where focussed efforts are required. Here, the work on the development of IIRR model and its implementation is one of the major challenges. Second, even though our first SRESA standard is at the advanced stages of publication, the work involved with other standards requires more work. Here, let us take e pledge to work on our objective and goals with focus on 'Excellence' in all our endeavours.

- **Prabhakar V Varde**

In this issue ....

Mathematical vs. Physical Reality of System Reliability Function

Author: Jezdimir Knezevic, MIRCE, Akademy, Exeter, UK

Abstract

According to author, the purpose of the existence of any functionable system is to do work. The work is done when the expected functionality (function, performance, and attributes) is delivered through time. However, experience teaches us that the work expected to be done is frequently beset by failures, some of which have safety consequences to: the users, the natural environment and human communities. Thus, from the late 1950s reliability models, based on a reliability function, have been used to predict the impact of the design decisions on in-service reliability and safety, before finalising the design. As the accuracy of these predictions is fundamental for the formulation of failure management policies, the author has studied the physical properties that future systems must possess, in accordance to the mathematical view of reality, firmly imbedded in their reliability block diagrams. These findings are tested through scientific studies of a large number of physically

observed failures generated by in-service processes of defence, aerospace, and nuclear power systems. The results obtained shown significant discrepancies between the mathematical ability, based on axioms of probability imbedded in reliability function, to embrace the physical reality observed through the scientific studies of numerous in-service reliability and safety related events. Thus, the main objective of this paper is to expose the reliability and safety community to the mathematical and physical realities of reliability function with the objective to focus their attention to the following question, *"What is the body of knowledge on which reliability and safety modelling should be based, during the design process, in order for predictions made to be confirmed by measures obtained in operationally defined physical reality?"*

1. Introduction

The necessity for the reduction in occurrences of operational failures started with the advanced developments of military, aviation and nuclear power industries, where the potential consequences could be significant. Hence, during 1950s, Reliability Theory was "created". It was based on mathematical theorems rather than on scientific theories. Massive attempts were made to further the applications of the existing mathematical, statistical and analytical methods without a real understanding of the mechanisms that caused the occurrences of in-service failures.

Deterministically educated engineers and mangers experienced fundamental difficulties in understanding Reliability Theory. The reason for that is very simple. Probability, as a main concept of reliability, cannot be seen or measured directly, unlike numerous measurable physical properties. For example: pressure, temperature, volume, weight of a component can be measured directly and by using appropriate mathematical manipulations, accurate predictions of the corresponding properties of a system constructed of these parts can be obtained. Although, the occurrence of a component failure is also clearly manifested and physically observed phenomena the concept of reliability is an abstract property that obtains a physical meaning only when an infinite sample of components/systems is considered, as far as mathematics is concerned!

2. Reliability Function

To support the above-presented conclusions regarding Reliability Theory, the fundamental definition of reliability will be used and analysed. It is widely accepted that Reliability is defined as the probability (*P*) that a considered entity (component, product or system) will operate without failure during a stated period of time (*t*), when operated in accordance with defined parameters. Mathematically, this statement is fully defined by the Reliability Function, R(t).

2.1 Reliability Function of a Component

For any component considered, the reliability function is defined in the following manner:

$$R(t) = P(TTF > t) = \int_t^\infty f(t)dt, \qquad t \geq 0 \qquad 1$$

where: *R(t)* is the reliability function, *f(t)* is the probability density function of the random variable known as the Time To Failure (*TTF*) of a component.

2.2 Reliability Function of a System

The Reliability function for a system, $R_s(t)$, is determined by the reliability functions of the constituent components and the way they impact the failure of the system. For example the reliability function for the system, whose reliability block diagram is presented in Figure 1, is fully defined by the following mathematical expression:

$$R_S(t) = P(TTF_S > t) = R_A(t) \times \{1 - [1 - R_B(t)][1 - R_C(t)]\}, \qquad t \geq 0 \qquad 2$$

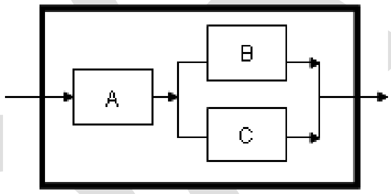


Figure 1: Reliability Block Diagram for a Hypothetical System whose failure will occur if a component A fails, or if components B and C fail

The above two equations briefly summarise the mathematical essence of the reliability function when the main concern is a prediction of the behaviour of the system until the first failure.

3. Mathematical Reality of a Reliability Function

Being educated to use mathematical expressions for all engineering deterministic predictions, which always have a single numerical outcome, the author has spent over a decade understanding the fundamental physical meanings of the mathematical expressions for the probabilistic predictions of system reliability. Thus, the realisation was that mathematics of reliability function dictates the following physical reality of the systems considered being applicable:

- One Hundred percent quality of components production and installation
- Zero percent of transportation, storage and installation tasks,
- One Hundred percent of components are mutually independent
- No maintenance activities (inspections, repair, cleaning, etc.)
- Continuous operation of the system (24/7)
- First observable failure is a failure of the system
- Time counts from the "birth" of the system
- Fixed operational scenario (load, stress, temperature, pressure, etc.)

- Operational behavior is independent of the physical location in space
- Reliability is independent of humans (operators, users, maintainers, etc.)
- Reliability is independent of calendar time (seasons do not exist)

In summary reliability predictions are correct, as far as mathematics is concerned, in all cases where the physical systems considered posses the above listed properties.

4. Physical Reality of Reliability Function

Systematic research performed by the author during several decades of the observable reliability performances of aerospace, military and nuclear power industries [1] have clearly shown that the flowing physical reality determines the reliability of systems:

- Quality of produced components and assemblies is less than 100%
- There are huge interactions between "independent" components
- Maintenance activities have significant impact on system reliability
- Neither all systems not all components operate continuously (24/7)
- First observable failure is not necessary the failure of a system (failure of components B or C alone, in the Figure 1, does not cause system failure)
- Components and a system have different "times"
- Variable operation scenarios (load, stress, temperature, pressure, etc.)
- Reliability is dependent of the location in space defined by GPS coordinates
- Reliability is dependent of humans, like: users, maintainers, general public
- Reliability is dependent of calendar time (seasons do not exist)

In summary, the physically observed reliability performances of in-service systems are undeniable driven by the above listed physical facts.

5. Closing Question

The paper has clearly highlighted the significant discrepancies between the mathematical ability, based on axioms of probability imbedded in reliability function, and physically observed in-service reliability performance of numerous aerospace, defence and nuclear power studied reliability and safety related events. Thus, it is inevitable to ask the reliability and safety community "*What is the body of knowledge on which reliability and safety modelling should be based during the design process, in order for predictions made to be confirmed by measures obtained in operationally defined physical reality?*"

6. References

Knezevic, J., The Origin of MIRCE Science, pp. 232. MIRCE Science, Exeter, UK, 2017, ISBN 978-1-904848-06-6

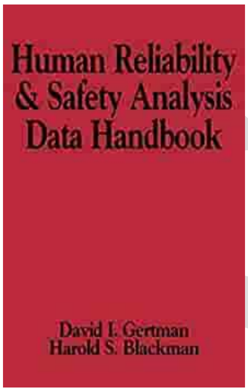
About the Author

Professor Jezdimir Knezevic, a founder of MIRCE Akademy, is a creator of MIRCE Science. It is a body of knowledge for determining functionability trajectory of systems, driven by natural and human actions, to compute expected performance with resources provided. The ability to predict the functionability performances of all competing design options is of fundamental importance for system engineers, program managers, investors, regulators and other specialists who are responsible for their safe, reliable and economical operation.

An Overview of the Existing Risk & Reliability Program and Future Academic & R&D Requirements in India – SRESA Perspective

Prabhakar V Varde, RRF, BARC, Prof. Homi Bhabha National Institute, Mumbai & Hon. Prof.-of-Practice, IIT Madras.

What was 'Quality' for business, over 50 – 60 ago, is Risk and Reliability in the present context and for future national and international eco-systems. This is just true not only for product or business but for complex safety critical systems that are in service and being developed in most of the sectors, be it space & aviation, nuclear, process & chemical, road & railways, structural systems like Dames, bridges building, etc and other state-of-the art structures. Apart from these, the software systems pose special challenges particularly when it is deployed for safety critical systems. For example, the nuclear industry, known to be a conservative sector, has critical evaluation as for as dependency on software systems alone. Of course, the provision of rigorous testing as part of validation and verification and adequacy of redundancy are implemented and evaluated employing multi-layer evaluation, etc, the issue of Common Cause Failure and uncertainty in level of completeness in testing poses as part of V&V programme poses challenges in terms of dependency on Digital System alone for the safety function in nuclear plants. Of course, there extensive work is being done in digital system reliability where apart from trying to understand new modes of failure, software reliability is an area where advanced R&D at national as well as international level forms part of defence-in-depth evaluation. The major objective is to develop a consensual framework for modelling of digital system reliability and its impact on postulated risk metrics,.e.g. core damage frequency, release frequency and finally risk to the public.

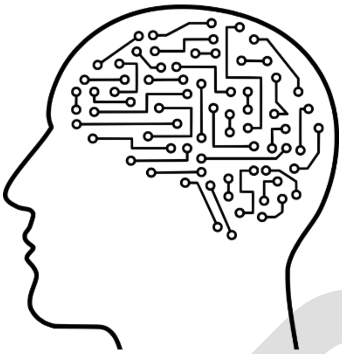


Based on the review of major accidents world over, there is a consensus that human contribution to accident is significant. In fact, there are many areas where further advanced research is required to ensure higher reliability and availability for hardware, software, and human interaction. For example, take the case of human reliability program. There is a consensus that human reliability data comes with higher uncertainty compared to hardware systems. There are three major approaches to human reliability assessment, a) plant specific data collection and analysis, this includes simulator experiments, b) handbook approach and c) data acquired from other / similar plants. Often the life testing experiments, even though in principle provide information of quality aspects, there exists an opportunity to derive information on reliability of the component. Even today it can be argued that the handbook approach is the most employed approach for human reliability. It may be noted these handbooks have been developed apart from the limited data that is available from the operating plants, mostly from the limited sets of experiments, expert opinion, or data available from other industries. Even though these generic models provide an elegant and very convenient approach to generate the estimates for a specific human action in HRA. However, one is not sure about the uncertainty that comes with these estimates. A general experience is it is higher and often one is required to perform a sensitivity analysis to assess the impact of these uncertainty estimates. In fact, it can be argued that these estimates may not represent the plant specific conditions / experience despite incorporating various modifying factors, for stress, context of the task, quality of human-machine interface, etc.

> *SRESA has this very ambitious vision of setting up world class National Institute – the Indian Institute of Risk and Reliability (IIRR) to meet national aspirations while meeting international norms in R&D and academics in the subject area.*

If we take the case of probabilistic risk assessment (PRA) of safety critical system, the insights and knowledge generated from PRA is extensively being employed as part of regulatory review or decision making through a risk-informed framework, one of its critical requirements that is quality of the data, needs special attention. In fact, there are two major observations regarding, let us say hardware reliability data. One, as for the operating plants PRA, ideally the plant specific data is required to make a specific case for the subject plant such that the applications of PRA can be more credible. Second, the data carries half information about the failure, i.e., the probability of failure and not the understanding the root causes or mechanism of failure. Even though the PRA is an effective tool for identifying, prioritizing, scheduling the plant activities, the reduction of failures of SSCs

(System Structures and Components) requires understanding of Physics or Mechanistic approach to model and track wear, and degradation such that corrective action can be initiated and that in turn works to eliminate or reduce the consequences of failure.



As discussed in previous para, the common cause failure (CCF) is a big monster as it knocks of the key safety or redundant provision and if the scenario involves external events, like seismic or flood events, there exists a potential to adversely affect the diverse systems. The probabilistic treatment to CCF, even though backed by quantitative models the fundamental process for quantification remains to a large extent, subjective in nature including the data. Here, possibly the deterministic approach provides the required ground, that involve, provision right through conceptualization, design, and operations the creating provision or defences against postulated CCFs. But even here also, as it happened in Fukushima the flooding of the basement knocked of the supply from emergency diesel generators (DG) due to location of the supply breakers and eventual flooding the DG room. Situation further aggravated due to unavailability of decay heat removal through steam water turbine driven shutdown cooling pumps. We need to accept the fact that CCF has its way even with all probabilistic evaluation and deterministic provisions. In fact, it is required that advanced deterministic approaches that involve physics of failure (PoF) based modelling that provides a system for prognostics and health management (PHM) has potential to solve to great extent the science of handling common cause failure. Similarly, the integrated plant model employing probabilistic risk assessment might identify the incipient failures, of course further R&D is required such that a dynamic approach is developed and employed identify and prioritize the critical areas, when the situation is evolving. In fact, this can be thought of as advanced version of Risk Monitor or Dynamic Risk Monitor (DRM) where the plant sensors feed the information to have realistic and timely assessment of the subject condition as it is evolving, particularly during emergency.

> What was 'Quality' for business over 50 – 60 ago, is Risk and Reliability in the present context and for future national and international eco-systems.

Whether it is hardware, software or human advanced methods and infrastructure is required that include simulation facilities, and advanced models and methods such that it is possible to develop correlation between the data obtained from the simulator are as close to real-time plant given human response to a particular scenario in general and accident condition in particular. This will enhance credibility of experimental or simulator data.

> *A dedicated National Level Institute with world class facility for Risk and Reliability R&D and Academics is the call of the day to fulfil state of the art development and cater to future advanced development*

It is a recognized fact that human factor is one of the major contributing causes to the accidents. In fact, be it TMI (1978), Chernobyl (1986) or Fukushima (2011), the major contributing factors were related to plant / organizational or national culture which manifested as human or organizational factors. Of course this subject has been well recognized at

all the levels, e.g. International Atomic Energy Agency (IAEA) has been spreading awareness about the safety culture and members are participating in these programs. However, there is still scope to improve the plant eco-system in terms of improving plant safety specially where either man-machine interface or organizational aspects need attention. One must recognize that for any framework to be on robust ground a scientific approach backed by quantified data and that in term the decision matrix is

required. Let us face it straight. Safety is a qualitative and subjective in nature and to great extent an indirect notion to address risk. To be more explicit our objective function is risk reduction or risk management. Then why 'Safety'. 'Risk' should be our operating metrics. What logically follows is why 'Safety Culture' why not Risk-Conscious Culture – as we are concerned about human reliability. This is where the PRA model of the plant can provide an effective framework for de-risking functions. Risk has mathematical connotation, and this creates pitch for facing the challenges directly using deductive and inductive logic at qualitative level and crisp approach to identification, prioritization and capturing of uncertainty employing quantitative methods.

Given the above background extensive R&D is being performed world over these schools and institutions are working on focussed areas for addressing specific challenges. In fact, some of the areas, like reliability data quality is concerned the approach that involves scientific tools and methods, like Physics-of-Failure are either at infant stages or is available in limited sense on specific domain with the elite labs. As for digital systems are concerned it is long way to go such that digital plant protection system are designed and implemented without any backup provision. This is required

for existing 2nd Generation Plants. For 3rd generation plants the proven passive and inherent features will make it manageable to have digital systems with due credits to inherent passive features.

The above, is a brief review of the state-of-the art and the gap areas and to some extent to evaluate the future R&D required for reliability improvement de-risking or risk-management.

The following is, again a brief overview of the major institutions involved in Risk and Reliability programme in India. In fact, what follows is a brief overview of state of the art in India and contribution of R&D, academic, regulatory, industrial houses and some selected private organizations or institutions. The objective here is to identify the strength of reliability and risk program in India. The basic aim of this article is to identify the features for enhanced, holistic, world class academic and R&D for Risk and Reliability oriented system. It's common observation that many advanced systems are developed and launched in the market based on initial testing

> Spirituality is at the core of Bharat – it's time to strengthen the value system based on moral and ethical codes and standards towards achieving higher level of security consciousness

and compliance to quality attributes. However, the call back due to potential 'risk, reliability and security' issues which involve huge losses and

reputation to the company is also an observation that we come across in print and digital media

This program provides for institutions for preparing qualified and trained professionals to cater to national needs in Risk and Reliability engineering. This institution will have Risk and Reliability Research infrastructure, facilities, and a pool of experts such that all the aspects related to domain specific requirements can be met under one roof. This institute will meet the aspirations of nation for Amrit Kal towards making India not only Atma Nirbhar but also offer a world class hub for risk and reliability research and development under one roof.

Before we finalise the charter, let us review in brief, the available expertise and infrastructure in India. This will require compile and analysis of information about the strength of risk and reliability programs in the existing major institutions and develop a blueprint for the establishment of Indian Institute for Risk and Reliability – a proposed project of Society for Reliability and Safety. To work on this project, it is required that information on the strength of each institution and their aspiration for advanced R&D and academics are available to understand the gap area along with the input and ideas that are central to create the Risk and Reliability program for the nation under one roof called Indian Institute of Risk and Reliability. each existing institution. For example, we already have input from Centre for Reliability (CFR) and the same was published in SRESA Newsletter issue 3 of 2022. This article provides the input that include expertise, facilities, objective and experience of CFR in the area of risk and reliability while its aspiration for the future R&D needs.

This work will go on in future publications of SRESA Newsletter. In fact, next

Newsletter, i.e. First issue of 2023 will carry an article from Nuclear Power

Corporation of India Limited (NPCIL) – the nuclear power house having 22 operating nuclear plants spread across length and breadth across India and mainly focussing on the Probabilistic Risk Assessment (PRA) of fleet of NPPs, that includes Pressurized Heavy Water Reactor (PHWR) having range of design from 220, 500 to 700 designs, Pressurized Water Reactor (PWR) of 1000 MW design, and Boiling Water Reactor (BWR) 220 Mwe designs. Then Bhavini (Bharatiy NabhiKiya Vidyuit Nigam) working on Fast reactor designs also have their PRA program. There are host of R&D, like Bhabha Atomic Research Centre (BARC), Semiconductor lab Chandigarh, Indira Gandhi Centre for Atomic Research (IGCAR), Indian Space Research Organization (ISRO),

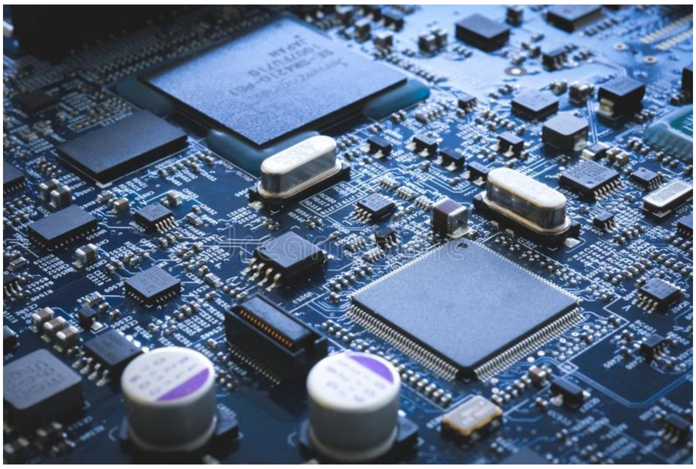
Defence Research Development Organization, and academic institutions, like

IIT, Kharagpur, IIT Madras, etc, having academic and R&D wings, Industrial organizations. Like Nuclear Power Corporations of India Limited, National Thermal Power Corporations, Automobile and many other sectors like Aviation, Road & Railways and Chemical / Process Industries There are many private institutions spread across India, like ARTL, Pune, involved in Life Testing where the major focus is to evaluate the components and products for reliability for their postulated service conditions. Apart from this, the regulatory agencies require reliability and risk assessment tools in support of review of proposals and studies and decision making. As mentioned, the application of risk-informed approach for regulatory review processes. For example, Atomic Energy Regulatory Board (AERB) having requirements in consenting as well as overall review of the PRA. The DGCA – Aviation regulator have the Root Cause Analysis or near miss event analysis along with other risk and reliability aspects directly or indirectly in place. The Financial Sector the Reserve Bank of India has application of a along with other review and compliance tools, application of a robust Risk-based approach to banking and financial institutions in the Country. Further, in health care sectors, that includes pharma industries and hospitals as also maintenance of related infrastructural systems and testing / lab facilities requires compliance related issues which pave risk and reliability as major a major aspects.

The current national enthusiasm where India is finding itself among the top few nations on the world scene and keeping in view the academic needs and industrial growth scene, it is high time that India has an integrated, robust, holistic system that is backed up by scientific models and ethical systems such that growth rate is supported while offering a platform for national as well as international learning and development in the area of not only quality, but Risk and Reliability. All of us get exposure to national and regional events through digital or print sectors. If you carefully observe, there are more than one, during some days it could be more events and issues that require attention on risk and reliability aspects. It may be related to transport, financial, aviation, healthcare, security, liability, structural, social, industrial, process or chemical, pharma etc. that requires an independent organization that exclusively deals with these aspects, i.e., risk or reliability issues. Further, India is entering into very ambitious plans particularly the electronics in general and semiconductor manufacturing which poses challenges related failure during manufacturing or operations. Similalry, in line with automobile sector where now we are sort of comfortable in terms of testing and quality assurance of components, the defence sector, keeping in view the bulk of expansion that is going on requires multi-fold strength in terms of facilities and human resource.

It's common observation that many advanced systems are developed and launched in the market based on initial testing and compliance to quality attributes. However, the call back due to potential 'risk, reliability and security' issues which involve huge losses and reputation to the company is also an observation that we come across in print and digital media

This article proposes aspirations / requirements of national level framework in India with world class R&D and academic to create Risk and Reliability conscious society with its fundamentals rooted in an integrated framework comprised of modern scientific and engineering models, value and administration system derived from Indian spiritual heritage and culture, that is directed to work on national aspirations. Be it scientific, technical, educational, societal, healthcare, defence, financial the major metrics for evaluation will be security, safety, human wellbeing, and happiness quotient. The major aim is

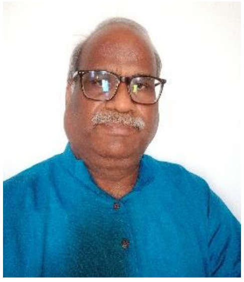


to create a holistic system that facilitates a interdisciplinary R&D and Academics. The objective of R&D programme include, Advanced Scientific Research that might range from classical to advanced areas like quantum mechanics, human behaviour modelling, simulations, artificial intelligence and machine learning, etc with an orientation on risk and reliability. The

academic orientation programme starts at graduate level through postgraduation and advanced degree, i.e. Doctor of Philosophy and further postdoctoral fellowships, again with an orientation of Risk and Reliability. The overriding objective function set for the Amrit Kal period is 'to make India Atmanirbhar in the area of 'Risk and Reliability with world class facilities by creating the subject national consciousness,

About the author

Prof. Prabhakar V Varde, is a Raja Ramanna Fellow, , and Senior Professor, Homi Bhabha National Institute, Mumbai, and Former Associated Director, Reactor Group BARC. He is also an Hon. Professor of Practice, IIT Madras. His specialization is nuclear plant operations, risk and reliability modelling and analysis. He is also Visiting Professor, at Center of Advanced Life Cycle Engineering at University of Maryland, College Park, USA. He successfully completed many R&D projects. He served as Vice-Chairman of the PSA Committee for DAE facilities of AERB for over and worked with international organizations, mainly International Atomic Energy Agency, Vienna, Nuclear Energy Agency, Paris, and national institutes like IIT Bombay, IIT, Kraraghpur, IIT Madras, IIT, and Delhi University etc. Presently he is also serving as President, Society for Reliability and Safety, India.



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Springer

Invitation for submission of Article

Special Issue on **Life Cycle and System reliability for Next-Generation Computing and Management.**

Spécial Issue Proposal Form

NAME OF THE JOURNAL: Life Cycle Reliability and Safety Engineering

TITLE OF THE SPECIAL ISSUE: Life Cycle and System reliability for Next-Generation Computing and Management.

NAME AND ADDRESS OF EACH EDITOR:

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Dr. Ajay Kumar Vyas	Department Electrical Engineering Adani Institute of Infrastructure Engineering, Ahmedabad, India	ajay.vyas@aii.ac.in
Dr. Narendra Khatri	Dept. of Mechatronics Manipal Institute of Technology, Manipal A Constituent Unit of Manipal Academy of Higher Education (MAHE) District: Udupi	narendra.khatri@manipal.edu

CV of the Editors: Attached

SPECIAL ISSUE FORMAT:

- Fresh Call for papers from eminent academicians/Researchers in the selected theme.
- 8 to 10 papers will form the SI.

SPECIAL ISSUE ORGANISATION:

Title: Life Cycle and System reliability for Next-Generation Computing and Management.

Abstract:

In recent scenarios, life cycle engineering is more adaptive to evaluate the cost-effective and efficient system modelling those concepts and methods of life-cycle engineering should be used to obtain a cost-effective design during a specified time horizon. The recent developments in life-cycle engineering of next-generation computing architecture based on system reliability, time-dependent reliability, life-cycle maintenance, life-cycle cost, and optimization constitute important progress.

Next-generation computing has transformed the technological challenges with minimum computational optimization costs. The next generation of computing systems integrates cloud, fog, edge, serverless and quantum computing with system reliability. Life cycle management is the primary key factor for the next generation network. Energy management and routing protocol enhancing network life cycle reliability is for the present and future networks.

Network generation computing is a growing field widely used as distributed systems. The advanced computing system provides data repositories, improves workflows, simplifies data, and creates real-time insights. It provides an AI-based platform for accessing information in various applications and is extremely popular in the industry and commercial use.

Various techniques, methods, and algorithms have optimized the reliability and life cycle optimization of many systems. Those algorithms can be made more efficient by applying AI-based techniques. They may implement innovative conservation techniques to improve the network performance, including maximizing the network lifespan. The lifecycle-based system reliability provides appropriate management of data amount, and node switching that sends data might provide further energy savings, extending the network lifespan.

The special issue objective is to provide the possibilities of AI-based life cycle systems for next-generation computing networks to explore the low power consumption or energy-efficient techniques and methodologies done by researchers and industrial people. The special issue is converging on original articles, reports, and experimental work based on the life cycle and system reliability for the different systems as Life Cycle and System reliability for Next-Generation Computing & Management.

The following topics are welcome but not restricted to:

Energy-efficient protocol
Next Generation Multi-Access Edge-Computing
Cloud-Fog Architecture-Based Energy Management
Decision-Making for Next-Generation Distribution Network
Prosumers and Internet of Things Devices
Energy Management Systems in Next Generation Network
Edge-Computing for Smart Microgrid Energy Management
Life Cycle of Light path in Intelligent Optical Networks
Multi-objective optimization
Life-cycle reliability-based optimization
Multi-state System Reliability
Life cycle risk assessment
Optimized energy management solution for heterogeneous clouds
Nanotubes for Next-Generation Computing
New generation energy systems and future Network
Life cycle cost optimization
Green system reliability assessment
Adaptive Clustering for next-generation wireless Network
Resource Management for Edge Computing Networks

KEYWORDS:

System Reliability, Life Cycle, AI, Next generation Computing and Management, Energy Management

REVIEW PROCESS:

Review process: Double Peer Review Process
Each submission will be verified in "Turn-It-In" for plagiarism. Papers below the 20% similarity index (including bibliography) will be accepted for review.

REVIEW / PUBLICATION PLAN:

Submission Deadline: 15 October 2022
First Round of Review Deadline: 15 November 2022
Notification of Acceptance/Rejection: 15 December 2022
Submission Deadline for revised/Final: 30 January 2023
Publication of The Special Issue: 2023

Society for Reliability & Safety (SRESA)

(Reg. No. : F-43051 (Mumbai))
SRESA Coordinator, Shri S.J. Raut, 64-Vibha, R. Paramhans Marg
Opp. Cardinal Gracious High School; Bandra(E) Mumbai - 400051
Web Site: www.sresa.org.in (Phone ; +91-9892464817)

Membership Application Form. **Membership No*.**

1.	Name of applicant		Affix your stamp / passport size photograph and send a soft copy by email
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4.	Position held		
5.	Specialization		
6.	Official address ☐	Residential Address ☐ (Please tick the address to be used for official communication)	
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9.	Date of birth (DD/MM/YY)		
10.	PAN Number (not applicable for student)		
11.	Type of membership (Tick applicable category)	Petron (By Invitation) : Nil Honorary Member (By Invitation): Nil Life membership : Rs. 2,200/- Membership (annual) : Rs 1200/- Student membership : Rs 500/- (Please tick the applicable category)	☐ ☐ ☐ ☐ ☐
12.	Payment mode: i) Cheque ☐ ii) Demand draft ☐ iii) On-line transfer: ☐ Cheque /DD/online transfer details :.........................Date: .... Amount: .... Name of the Bank:........................Account number............ISFC code		
12	Signature of applicant:		

- Please send the scanned copy of the form duly signed by email to Secretary. SRESA along with a soft copy of the passport size photograph to secretary@sresa.org.in and a copy to treasurer@sresa.org.in
- SRESA account details are as follow: Money to be transferred in favour of 'Society for Reliability and Safety'. SRESA Account number: 31110442604. Bank Name: State Bank of India. Branch: Anushaktinagar, Mumbai 400094. Branch Code 010124. IFS Code: SBIN0010124.
- *will be allotted by SRESA Office.