



Farewell Henk

For ESReDA
Mohamed Eid
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To the memory of our dear colleague and friend Henk Wels who passed away on October 31st, 2023.

Maintenance modelling and power plant reliability & RAM models



Henk Wels
Consultant,
The Netherlands

Since 1988 at DNV legacy companies KEMA and NRG we have been modelling conventional power plants as well as other infrastructures. The parameters of interest were RAM, with R = Reliability (does not fail often), A = Availability (it's there when you need it) and M = Maintainability (easy to repair). While due to having access to failure information from dedicated databases as well as using failure and maintenance information from projects, a RAM model never was that difficult. We have applied RAM specification in order to have an optimum plant right from the begin of operation and were successful in that. The model, usually on the basis of a Reliability Block Diagram producing system states such as full outage, 10 %, 20 %, etc. outages resulted in predictions for new buildings, life extensions, focus on dominant components and subsystems, gave quantitative decision material for spares, etc. I'll come to the underlying data for such models later. However, the quantitative relation between failures (CM) and preventive maintenance (PM) always has been clouded. We started using simplified bathtub curves given by 3 straight lines (teething troubles, midlife, ageing) with a component As Good As New (AGAN) after failure. However, the basis for AGAN except for print cards, components with strong degradation processes, etc. was meagre and not according to practice at power plants. At plants components are inspected, degradation is removed (or not), and components are repaired rather than replaced. Furthermore, the optimum replacement times were often at the start of ageing.

An interesting next step was application of engineering judgement for steam turbines of degradation trajectories (therefore a p-F curve) and varying the overhaul interval together with a probability of detection of the degradation and subsequent removal of degradation. Failures were thought to occur if degradation was not detected before overhauling or if shock types of failures would occur. As steam turbines in principle should show little degradation, overhauling steam turbines to improve reliability shows only a weak and large optimum interval. There is also a case for no overhauling at all.

It was therefore a pleasure that as the result of long-term good relations with vgbe, that the vgbe 444 R&D project could be carried out aimed at modelling and estimating maintenance efficiency from practice data at power plants. The project results are published in vgbe Energy Journal 5 – 2023. Essentially using the failure rates derived from the raw data in vgbe's KISSY database as well as from PM and CM information from 4 partner utilities, ARA = Arithmetic Reduction of Age models were used to investigate the relation between PM and CM maintenance. In ARA, the coefficients ρ PM and ρ CM for life reduction at overhauls and repair are calculated from the failure data and therefore AGAN of As Bad As Old ABAO does not need to be postulated. Yet it was found that the results were much more dependent on the ageing coefficient β than on ρ . Differences in failure intensity α between plants were substantial showing the need to model plant specific preferably.

The 444 R&D projects showed also that there are many cases without ageing and with improvement of components over long periods that are reasonably well predicted choosing a ABAO model with a β . The choice for β is underpinned by checking time between failures in terms of a Fix Efficiency Factor FEF when times between failures are increasing. Some 190+ time series from vgbe's KISSY were investigated covering 224 coal-fired, lignite-fired and gas fired (CCGT) plants together with plant specific PM and CM information from 18 coal fired and CCGT plants of our utility partners. It led to ρ , α , β and FEF distributions all duly documented.

As DNV is involved in the OREDA databases, we asked access to the raw OREDA failure information in order to calculate maintenance efficiencies in line with Haugen et al. Using degradation trajectory types, we were able to access the failure rate if NO PM maintenance would be carried out for gas turbines, pumps and other components, also duly reported in the vgbe 444 R&D projects. The full vgbe 444 R&D projects report at the moment is only available to vgbe, DNV and the utility partners that have invested in the project.

As we could analyse much earlier using the information from the Dutch failure database from Sep, which was stopped due to liberalization in the 90-ties, "humps" can be seen in the curve for the cumulative failures as a function of time. These "humps" seem to be caused by the occurrence of unexpected failure mechanisms that are not immediately resolved. As the "humps" point to proper root cause analysis of specific failures as well as spoiling to have precise coefficients for ρ , β , etc. over long periods of time, they should be prime targets for analyzing how to have better plants in new R&D projects.

So far for modelling the PM – CM maintenance relation. I have mentioned the vgbe KISSY database on power plant failures before. International utilities supply their unavailability information on the plant as a total to this database which can be assessed for on-line analysis when reporting to this database. The vgbe also makes an overview report on a yearly basis. A substantial part of the utilities also supplies more detailed information subsystem and component failures based on a 3 letter KKS coding system which is also reported on a yearly basis. However, this report does not contain the typical RAM parameters of interest to reliability engineers. The raw failure data were therefore analysed in the 2013 vgbe R&D 361 project to derive failure rates, repair times, ageing coefficients etc. per plant per subsystem using data over the period 2002 – 2011. As more recent data became available from the vgbe 444 project, it was decided to update the 361 analyses using the 2009-2020 failure data. With DNV having delivered the final report to vgbe early 2023, vgbe is to make the report available as a common vgbe – DNV report at the vgbe web shop soon. It will contain on a subsystem level failure rate, repair time etc. as well as for Pareto dominant components a set of standard plots showing how failure rates, repair times and forced unavailability change with age of the plant, number of operating hours and starts per year. The KISSY database is to be extended with a reliability module hopefully as per 2023 and a proper specification of the software for such a model has started.

It does not pay to gather detailed information for every subsystem in a plant as one needs to know the capacity and number of components in each plant etc. and not all subsystems are dominant with RAM. Yet the underlying DNV spreadsheets allow calculating even if no details are present on a 1 or 2 letter KKS detail level. Component failures based on other more detailed databases should add up to the vgbe KISSY subsystem level. Using engineering judgement, KISSY can also be used to assess RAM on component level for instance for step-up transformers or turbine feed water pumps. Redundant subsystems always are a little troublesome as utilities only report outages of the plant. At redundant systems such outages occur for instance due to common cause failures of components. Therefore, estimating common cause failure coefficients is a standard reporting feature in the common vgbe – DNV report. Similar for the fraction of failures at a specific KKS-code larger than say 8 or 24 hrs. This fraction gives clues about the feasibility to apply spare parts as evidently inserting spares take time. It is part of the input for detailed spare part modelling using Monte Carlo analysis such as for instance at GT blading.

In short: modelling of systems using RBDs is rather straightforward. Component and subsystem failure rates and repair times can be derived from databases such as vgbe's KISSY database. When available, ORAP, EPRI, Nerc Gads etc. should also be consulted. RBDs should be able to model system states such as total outage, partial outage (10%, 20%, etc. loss) and calculate both the frequency and duration of such system states. The RBDs can be made a function of time using Monte Carlo modelling and the vgbe – DNV report gives clues what β s are reasonable for such time series. The models are very valuable for newbuilding, life extension purposes, etc. The quantitative relation between PM and CM maintenance still has not been completely solved however an important step forward was made. The quantitative relation can be improved using ARA and FEF models, ρ -coefficients, β 's etc. Of prime importance is information from maintenance databases discussed with plant maintenance engineers and explained using this information

Editor Note:

See also Henks C. Wels book on: Failures and Forced Unavailability of Power Plants

The book is derived from earlier papers presented at ESReDA, PGMON, VGB working groups and other committees and projects when working with KEMA and its legacy companies and departments NRG, DNV GL and DEKRA.

The book contains a small failure rate & repair time database as well as a description of E-planning in the Netherlands from the 60-ties until now. Available at [VGB website](#).

Cindynics: An inductive approach addressing the 2050 challenges.



*Jean-François Raffoux
ESReDA Honorary
President*

Our society is facing hybrid threats affecting its various components in different but linked domains (social, economic, technical, layout, environmental...) in a context of climate change, rapidly evolving technologies not always under control, pandemic crisis, international political and social instability.

Faced with the dangers and related risks affecting nature, individuals, stakeholders, and their assets, new or brought up to date concepts such as resilience, anti-fragility, show at the front pages of seminars, congresses and various media dealing with risk management. Their goal is to promote anticipatory actions (ahead of aggressive situations) in order to strengthen our defences and enhance our ability to react and recover.

For many years, risk researchers and managers have efficiently developed and implemented methods and tools involving various and sometimes sophisticated empirical, analytical, and probabilistic approaches. These approaches are mainly « deductive » aiming to identify and failures and weaknesses of technical systems, processes and their operators and offer remedies to respond and take over.

In our complex and quickly evolving society it seems important to implement a more « inductive » approach considering firstly the context in which various threats can be expected, identifying hazardous situations, stakes and assets at risk and addressing the main stakeholders involved

The analysis of the stakeholders' behaviour as single entities, as well as interactive entities, a will reveal both weak points and strength when faced with the encountered situations.

Such an approach is the domain of Cindynics.

This approach would be appropriate to identify, anticipate and mitigate dangerous situations exposing stakeholders but also to deal with the climatic situation and the challenge of carbon neutrality 2050 goal online with the 2015 Paris agreement.

To reach this carbon neutrality various scenarios have been proposed involving four major stakeholders : State, Local authorities, economic agents (industry, agriculture, services), and citizens.

These stakeholders, themselves comprising several actors, are involved at various degrees according to the scenario adopted. Each scenario should comply within a scaled agenda towards 2050 with specific objectives for the stakeholder and related actors.

Noncompliance with these objectives is an obstacle for reaching the final objective and failure to achieve these objectives presents a risk to the achievement of the overall objective.

The « Cindynic » approach aims to:

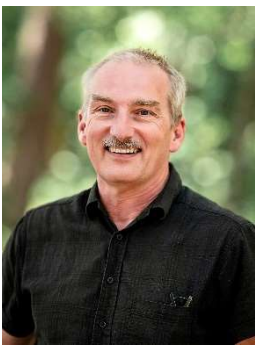
- Determine for each actor how to reach his objectives taking into account his own values, evolving rules and regulations, data which need to be continuously updated and adequate technical and socio-economical models
- Evaluate each actor performance by comparing what is expected from him with his actual results, thus, this will detect obvious deviations and induce corrective measures of his action.
- Link the different actors between them, identify opportunities to work together towards common objectives.
- Highlight the inconsistencies between the actors impeding their routes towards their objectives. This should induce cooperative actions, seek consensus, and avoid conflictual situations.

Implementing such an approach requires a trial phase involving an adequate territory and the cooperation of motivated actors.

It should then be reviewed and extended to the major stakeholders, contributing to the carbon neutrality plan, of wider territories.

This « inductive » Cindynic approach is nevertheless additional to the ongoing methods used to improve safety, reliability and resilience which are displayed and promoted by ESREDA with diligence and efficiency through its seminars, project groups and releases.

Staying in control with modern complex systems



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*Senior Principal Specialist
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Modern, digital systems have tendency to increase the system complexity, often to the point that single persons are not able to keep an overview over their functionality and how sub-parts are connected. The question arises, how we still can ensure adequate quality, especially with respect to critical functions. Here are some elements which should be considered crucial in the lifecycle of complex systems:

- **Concept Qualification.** In an early stage of the system design and during modification planning, the concept phase should be seen as crucial. Together with all stakeholders the high level properties of the system, limitations, assumptions, risks and use cases are identified and clearly understood by all stakeholders. The information collected and agreed in this phase should comprise anything needed to be known in the following phases. Issues forgotten are most probably leading to delays, confusion, errors, and project overruns.
- **Risk Assessment.** Uncertainty with respect to objectives need to be identified and discussed so that no unacceptable such uncertainty remains. It is important that analysis techniques are adapted such that they can cope with emerging (complex) behavior, i.e. interactions of components that lead to non-intuitive behavior on system level. Often analysis techniques like system simulation might be necessary to properly understand the system. The results of the risk assessment should also be used in the system verification and validation phase.
- **Assumptions and limitations** must be kept track of throughout the lifecycle. During planning and design it is all too easy to not document such information, such that it is lost to actors downstream the lifecycle, leading to confusion and errors. The information should be kept at a central place, easily accessible by all stakeholders.
- **Actions management.** Also agreed actions should be kept in a central place, accessible by stakeholders according to their role in the project. The action list must be reviewed regularly with all relevant parties.
- **Simulation models.** Since complex systems are not easy to understand intuitively, it is often necessary to gain insights and decision support from simulation models. It should be remembered that “all models are wrong – some models are useful”, i.e. by intention a model is an abstraction of the system with respect to selected aspects. With respect to other aspects the model will fail or even deliver misleading results. That must be kept in mind when designing and using simulation models. In many ways, a simulation model is a complex system in its own right and should be treated as such.

The list above is not complete, but may provide some insight and might serve as a starting point for follow-up discussion – feel free to drop me a message.

The 64th ESReDA Seminar



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64th ESReDA Seminar on Digital Maintenance in the Digital Twin Era. 30-31 May 2024, Universidad de Deusto, Bilbao – Spain.

Digital Twins (DT) technology has become indispensable for understanding and deciphering the utility of current developments, unlocking the potential of digital transformation.

It operates like the keystone in an arch, seamlessly bringing together diverse elements of digital technologies and modeling techniques. This synergy creates a unified structural entity, crucial in the emergence of new and complex System of Systems (SoS) structures.



One of the most significant areas where this transformation is expected to make waves is **Digital Maintenance**. Analyzing how maintenance can benefit from this evolution is essential. The advent of new technologies has made the maintenance landscape more intricate, requiring efficient management of vast information and predictive alarms within dynamic schedules.

However, the complexity of the maintenance management process often hampers the technology's impact on organizations. Conventional maintenance practices persist, causing delays in embracing digitalization and hindering the expected return on investment for companies undergoing the digital transformation effort.

Furthermore, **the role of individuals in the context of maintenance digitalization** is critical. Embracing digital transformation offers an opportunity for human evolution, leveraging the expertise and experience of employees in the new digital environment. This provides a competitive edge in driving innovation and technological progress.

Join us at the 64th ESReDA seminar, where researchers, practitioners, and experts from various disciplines converge to share insights and advancements in the realm of digital maintenance and its relationship with digital twins, complex systems, and human resources. Topics include, but are not limited to:

1. Advancements of Digital Twins in Complex Systems Generation.
2. Current Barriers in Implementing Technologies for Real Maintenance Evolution.
3. The Role of Human Resources in the Context of Digital Maintenance and Digital Twins.

Bilbao, Spain, will host the 64th ESReDA Seminar on **May 30th and 31st, 2024**. Nestled along the Nervión River, Bilbao seamlessly blends rich history with cutting-edge architecture, epitomized by the iconic Guggenheim Museum designed by Frank Gehry. Participants will have the chance to immerse themselves in the lively Old Town, savor exquisite Basque cuisine, and explore a city that exudes charm at every turn. Join us for an event that marries knowledge exchange with the cool vibe of Bilbao.

We look forward to welcoming you to this unforgettable experience!

Abstract submission deadline: 20th January 2024

The 65th ESReDA Seminar

65th ESREDA Seminar From risk imagination to safety intervention - Managing risks with knowledge, November 2024, National Center for Scientific Research "Demokritos", Athens, Greece

ESReDA's "Risk, Knowledge, Management" (RKM) project group (PG) addresses the intricate relationships between risk, knowledge and management, aiming to find new ideas for preventing accidents and improving safety management with better utilization of



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knowledge. The RKM PG wishes to organize the 65th ESReDA seminar to foster an exchange of ideas and experts' debates. The NCSR Demokritos in Athens will provide the forum.

The 65th ESReDA Seminar follows the successful 58th ESReDA Seminar on "Using Knowledge to Manage Risks and Threats: Practices and Challenges", organized by JRC Institute of Energy (Petten, the Netherlands) and held virtually in June 2021 during Covid-19 pandemic.

Though we are told we live and work in "information and knowledge" society, preventing accidents and enhancing resilience, through the use of relevant safety knowledge and expertise is not granted and requires continuous efforts to overcome the hurdles in an "age of uncertainty".

The main objective of this forthcoming seminar is to identify the enablers and barriers to the production of knowledge concerning safety risks and resilience and to its effective use in decision-making and other management and operational activities. The key problematic question we will ask is: "What do a management team, a regulator and a front-line worker need to know and is able to use to manage risks effectively?".

The call for papers will be announced soon on ESReDA website.

Past ESReDA Seminars

The 63rd ESReDA Seminar

Chairwoma
Kristine VLAGSMA
(European Commission,
Joint Research Centre)



Organiser
Vytis Kopustinskas
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Resilience assessment: Methodological challenges and applications to critical infrastructures 25-26 October 2023, JRC, Ispra – Italy.

Research in resilience of infrastructure systems has been constantly increasing during the last decade and is expected to grow further. Resilience applications in technical systems domain have evolved most significantly during the last two decades and the term resilience has already been transferred to the policy domain, as the Directive on the Resilience of Critical Entities (CER Directive) went into force in January 2023 and replaced the Critical Infrastructure Directive, published in 2008.

Two fundamental points in resilience domain to be addressed by the Seminar are:

- The methodological development of resilience assessment from a conceptual framework to modelling approaches.
- The metrics for resilience assessment and development of quantitative tools for decision making.

The 63rd ESReDA seminar explored these points and other related questions. We discussed theories, concepts, and experiences of resilience assessment methodologies and applications. Authors were invited to present their proposals and discuss successes and/or failures and to identify future needs in resilience research. We wanted to encourage new ideas, scientific papers, conceptual papers, case studies and cross-sectoral research on this topic with examples and applications of infrastructures exposed to both technological and natural threats, hazards. The seminar brought together some 50 researchers, practitioners, and decision-makers. While some 25 papers and invited keynotes were presented.

The proceedings will be soon available for free downloading on the EC JRC Docs site.



The 62nd ESReDA Seminar



Alberto Martinetti
University of Twente,
the Netherlands

The 62nd ESReDA Seminar on Managing the unexpected: designing systems to embrace disorder for increasing asset reliability

April 12th – 13rd, 2023, University of Twente, the Netherlands [62nd ESReDA Seminar](#)

Dealing with complex systems has certain characteristics that require consideration to be managed successfully. Understanding and dealing with unexpected events and the unknown are major challenge in asset management.

Unexpected drifts from normal working conditions pose several concerns about the decrease in safety levels as well. Despite the enormous changes and developments in the industry in the last decades as ‘an unprecedented fusion between and across digital, physical, and biological technologies’, approaches for guaranteeing comparable safety and reliability improvement do not evolve quickly enough to offer adequate solutions in managing the mentioned complexity.

Complex assets require a different approach to dealing with unpredictable events and disorder. Consequently, it appears necessary, during the design phase of a complex system, to use tools and techniques for both withstanding stress and becoming stronger but without the necessity of predicting every circumstance. Reliability professionals are in need for ‘antifragile’ methods for embracing disruptive situations and unknowns.

The seminar was attended by more than 20 experts from academia and industry. They discussed the application of concepts, the state of the art and current developments in contingency management in complex systems, as well as new techniques and methodologies and their strengths, weaknesses and uncertainties to improve reliability.



The 61st ESReDA Seminar



Micaela Demichela
Politecnico di Torino,
Italy

The 61st ESReDA Seminar on Advances in Modelling to Improve Network Resilience

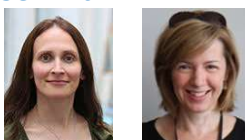
22-23 September 2022, Torino, Italy. [61st ESReDA Seminar](#)

Climate change and the delays in adopting the necessary measures to manage it is increasing the number of disrupting events triggered by natural events. Sudden failures or gradual deterioration of system components due to natural events can bring to malfunctions, loss of containment and disruptions, whole likelihood is going to increase in the next future.

In recent years several methodologies and techniques have been proposed, able to take into account explicitly and in realistic way NaTech events, able to support the decision making in terms of prevention, protection, adaptation and management. NaTech events have also another dimension to be considered, that is the territorial one, again in terms of prevention, management, and resilience.

The aim of the seminar was thus to discuss the state of the art and on-going developments in the NaTech risk assessment techniques and methodologies and to discuss their strength, weakness, and uncertainties in the assessment of the safety and resilience of complex systems.

The 60th ESReDA Seminar



The 60th ESReDA Seminar on Advances in Modelling to Improve Network Resilience, 4-5/5/2022, Grenoble, France

The seminar has been organized by the University Grenoble Alpes under the Risk@UGA Idex project framework and hosted by Grenoble INP ENSE3. It has been a forum for exploring issues related to engineering resilience against different threats, such as failures of aging infrastructure, natural disasters and climate change, intentional attacks (cyber-security and terrorism), and emerging threats, met by different industries, critical infrastructures and urban settlements.



Rasa Remenyte-Prescott
 Kate Sanderson
 John Andrews
 Univ. of Nottingham, UK

This seminar closed a 3 years project group “Resilience Engineering and Modelling of Networked Infrastructure”, managed by the University of Nottingham, particularly J. Andrews and R. Remenyte-Prescott (in the center of the group picture). Contributions have covered a wide range of topics concerning several stakeholders, from practitioners to researchers (industrialists, regulators, safety boards, universities, R&D organisations, engineering contractors and consultants, training specialists) who presented their work in sessions about resilience of Electrical Networks, transport networks and Smart Cities, Infrastructure Networks... Theories, concepts, and experiences of methods for improved network resilience have been discussed.

Authors have been invited to present their research and experience and discuss challenges in enhancing resilience through modelling. Papers have been published soon in JRC Technical Notes.

The proceedings can be downloaded [here](#).



Christophe Berenguer,
 Sylvie Perrier,
 Jean-Marc Tacnet
 Julien Baroth
 Univ. Grenoble Alpes, FR



ESReDA members’ running projects

NxGen Project - University of Nottingham (UK)



Prof. John Andrews
 Resilience Engineering
 Research Group at the
 University of
 Nottingham (UK),
 NxGen Project Lead

Our team in the Resilience Engineering Research Group at the University of Nottingham are leading a challenging project to develop a new generic methodology for improved system safety analysis.

Informed by our industrial partners in the aerospace, rail, and nuclear sectors, this 5 year project, funded by Lloyd's Register Foundation, proposes a step change in modelling capabilities, to represent more accurately modern engineering systems, which are rapidly increasing in size and complexity.

The foundations of current risk assessment tools and methodologies for safety critical systems were established in the 1970's. Technology has advanced, and system designs, their operational conditions and maintenance strategies, are now significantly different to the types of systems that existed 50 years ago. This can limit the capability of current prediction methods to adequately represent their failure performance where; dependencies exist between components; components degrade over time; and complex asset management strategies are employed.

The challenge of this 5 year project is to account for all of these factors in developing a single methodology appropriate to meet the demands of modern industrial systems and to implement this in a software tool that has the potential for wide distribution and impact. The tool could be adapted by users to reflect the needs of their individual system assessment characteristics.

The project's progress will be regularly published in its newsletter. In this inaugural project newsletter, we aim to delineate the project objectives and introduce our evolving modelling framework - Dynamic and Dependent Tree Theory (D²T²). Our goal is to initiate discussion and collaboration, disseminate our discoveries, and elicit feedback. The inaugural issue can be accessed at the following link:

<https://www.nottingham.ac.uk/research/groups/resilience-engineering/nxgen-project/nxgen-newsletter.aspx>

ESReDA Project Groups - News



Rasa Remenyte-Prescott
University of Nottingham, UK

John Andrews
University of Nottingham, UK

ESReDA Project group on Resilience Engineering and Modelling of Networked Infrastructure

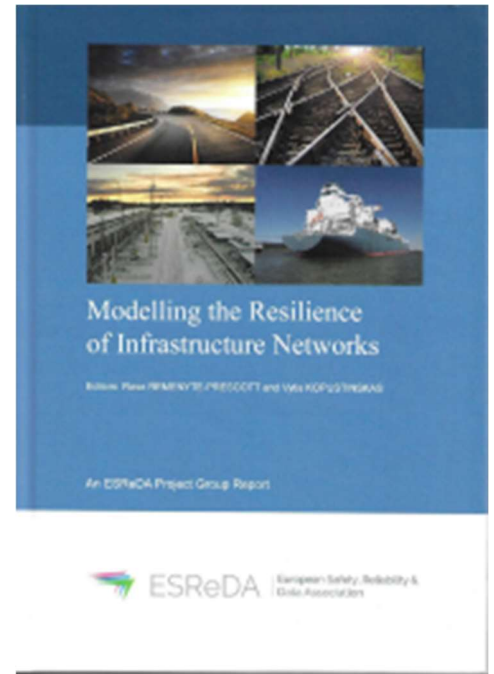
Findings from the project group have been published in a book entitled “Modelling the Resilience of Infrastructure Networks”, edited by Rasa Remenyte-Prescott and Vytis Kopustinskas.

This book is a selection of contributions written by members of the Project Group and concentrates on the themes of transportation and utilities. The papers intend to provide an insight into the state of the art of resilience modelling with a focus on Networked systems. The book is aimed at both an industrial and academic readership with interests in the resilience of engineering systems.

We would like to thank the authors for their contributions to this publication, and our colleagues at DNV for their practical support with printing and distribution.

For information on how to purchase a copy please contact aguillen@us.es ESReDA General Secretary, Antonio J. Guillén (Ingeman, Spain).

Book Purchase Order is joint to the newsletter



ESReDA RKM project group: Risk, Knowledge, and Management



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The Risk Knowledge and Management Group is continuing its activities. During the last group meeting on the 22nd of February 2023 there was a shift-over of the Group Leader from Eric Marsden to Myrto Konstantinidou and an updating on the status of the discussion papers.

Currently, we have 14 discussion papers under preparation and another 6 under discussion. One is ready to be published in June 2023 and the rest will be published eventually until February 2024. The first one is entitled “Delegation of safety oversight” and it has been prepared by Eric Marsden. We are also planning to host a workshop and ESReDA Seminar in 2024, probably in Athens.

Delegation of safety oversight is a discussion paper on Risk, Knowledge and Management (RKM). It aims to share information on ongoing work undertaken in the context of the RKM project group. It is actually available for downloading [here](#).



ESReDA Honorary President
Jean-François Raffoux

Reliability of Nuclear Power Plants Methods, Data and Applications

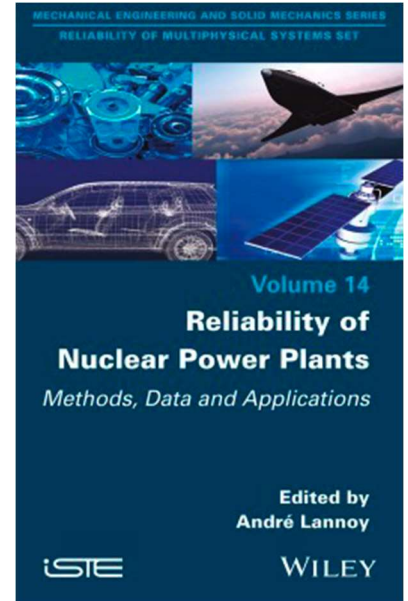
Abdelkhalak El Hami

Since the 1970s, the field of industrial reliability has evolved significantly, in part due to the design and early operation of the first generation nuclear power plants. Indeed, the needs of this sector have led to the development of specific and innovative reliability methods, which have since been taken up and adapted by other industrial sectors, leading to the development of the management of uncertainties and Health and Usage Monitoring Systems.

In this industry, reliability assessment approaches have matured. There are now methods, data, and tools available that can be used with confidence for many industrial applications. The purpose of this book is to present and illustrate them with real study cases. The book addresses the evolution of reliability methods, experience feedback and expertise (as data is essential for estimating reliability), the reliability of socio-technical systems and probabilistic safety assessments, the structural reliability and probabilistic models in mechanics, the reliability of equipment and the impact of maintenance on their behavior, human and organizational factors, and the impact of big data on reliability. Finally, some R&D perspectives that can be developed in the future are presented.

Written by several engineers, statisticians and human and organizational factors specialists in the nuclear sector, this book is intended for all those who are faced with a reliability assessment of their installations or equipment: decision-makers, engineers, designers, operation or maintenance engineers, project managers, human and organizational factors specialists, experts and regulatory authority inspectors, teachers, researchers, and doctoral students.

The book can be ordered [here](#).



Pierre Dersin
Consultant en System Safety,
Reliability, and Maintenance
Modelisation & Analysis

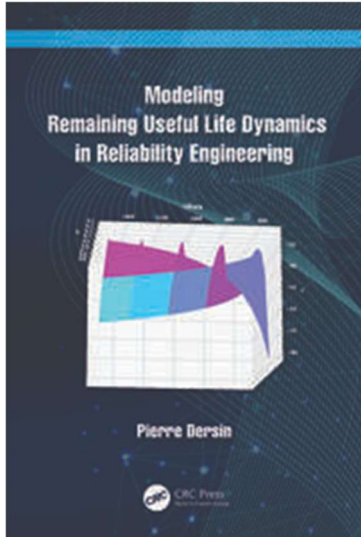
Modeling Remaining Useful Life Dynamics in Reliability Engineering, CRC Press, June 2023.

Pierre Dersin

This book applies traditional reliability engineering methods to prognostics and health management, and specifically Remaining Useful Life (RUL) dynamics.

In the context of the digital transformation, the last two decades have witnessed a significant evolution in the theory and practice of industrial maintenance : information and communication technologies now make it possible to replace traditional maintenance (i.e. scheduled preventive and corrective) with predictive maintenance, based on estimation and prediction of individual asset state of health.

To that end, an invaluable decision support tool is the estimation of asset remaining useful life (RUL). RUL is a function of time ; it is also stochastic since it is affected by observation errors, variability of environmental conditions and mission profiles, and imperfect knowledge of degradation mechanisms . Taking that uncertainty into account is essential for sound risk management . Failing to do so will generally lead to inappropriate maintenance decisions.



Methods used to estimate RUL are numerous and diverse and, broadly speaking, fall into three categories: model-based, data-driven, and hybrid. The author starts by building on established theory and looks at traditional reliability engineering methods through their relation to Prognostics & Health Management (PHM) requirements and presents the concept of RUL loss rate. Following on from this, the author presents an innovative general method for defining a nonlinear transformation enabling the mean residual life (MRL) to become a linear function of time, which leads to explicit analytical results, for instance for RUL confidence intervals and RUL probability distribution.

He applies this method to frequently encountered time-to-failure distributions, such as Weibull, gamma and lognormal, and first-hitting times of stochastic processes such as the Wiener or gamma process, used to model degradations. Latest research results, including the author's (some of which were previously unpublished), are drawn upon and combined with very classical work. A complete chapter is devoted to the examination of the properties of the time transformation that allows for the linearization of the MRL. Statistical estimation techniques are then presented to estimate RUL from field data

Finally the use the results for maintenance support and in particular predictive maintenance, is discussed. A risk-based method for predictive maintenance optimization is presented. The book ends with suggestions for future research, including links with machine learning. Industrial applications are described and every chapter is followed by a series of exercises. The book is of interest to engineers, researchers and students in reliability engineering, prognostics and health management, and maintenance management.

<https://www.taylorfrancis.com/books/mono/10.1201/9781003250685/modeling-remaining-useful-life-dynamics-reliability-engineering-pierre-dersin>

Forthcoming Conferences & Seminars



ESREL2024

the 34-th European Safety and Reliability Conference

23-27 JUNE 2024

Jagiellonian University, Cracow, Poland

The ESREL 2024 Conference is accompanied with the Post ESREL 2024 Workshop, 28-30 June 2024.

ESREL is the annual event in the area of reliability analysis, risk assessment, risk management and optimisation of the safety performance of socio-technological systems. This conference runs under the auspices of the European Safety and Reliability Association (ESRA, <https://esra.website/>).

This time it is organized by Polish Safety and Reliability Association (PSRA, <http://ptbn.pl/psra/>).

The Post ESREL 2024 Workshop is dedicated to training courses and research projects in reliability, safety and security.

The conference venue is in the city of Cracow, a city at the southern part of Poland, one of the European Capitals of Science, Culture and Tourism (link to ESREL 2024 in CRACOW, POLAND-Presentation)

The conference and the workshop will be held at the Faculty of Mathematics and Informatics of Jagiellonian University (https://en.uj.edu.pl/en_GB).



Sustainable and Digital Innovation in Engineering Asset Management. July 3 - 5, 2024, Lisbon, Portugal

CONGREGA 2024 seeks to push the boundaries of SUSTAINABLE AND DIGITAL INNOVATION in Lusophone (Portuguese-speaking) and Hispanic (Spanish-speaking) countries and communities spread across Europe, the Americas, Africa, Asia and Oceania.

It is expected to gather over 300 delegates to share state-of-the-art knowledge in research and applications of advanced management and digital and deep-tech solutions enabling excellence in ENGINEERING ASSET MANAGEMENT.

<https://congrega.eu>



BEMAS Formation

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BEMAS - Belgian Maintenance Association vzw-asbl

For details: <https://www.bemas.org/en/trainings>

ESReDA Members, you are kindly invited to contribute to the ESReDA newsletter sharing news, announcement of events, your experiences, ideas, etc. You are supposed to elaborate proposals to create new Project Groups, host ESReDA Seminars or initiate collaborative activities.

ESReDA: European Safety, Reliability & Data Association

Association internationale sans but lucratif, régie par la loi Belge du 27 Juin 1921-Titre III (Registration N°: 0452522618 - Siret:E00005802)
Headquarter: ESReDA, rue Gachard 88 Bte 14, B-1050 Bruxelles, Belgium

Contact ESReDA | info@esreda.org

64th ESReDA Seminar On Digital Maintenance in the Digital Twin Era.

May 30th – 31th, 2024,

The Digital Twin Week
University of Deusto, Bilbao (Spain)



Announcement and Call for Papers

64th ESReDA seminar within **The Digital Twin Week. Bilbao May 27th-31st, 2024**

The 64th seminar will part of a coordinated activity of [ESReDA](#) jointly with the projects founded by the European Union [BUILDCHAIN](#) and [ENHANCE](#). In addition to the 64th ESReDA seminar the **Digital Twin Week** include the celebration of a **doctoral workshop on digital twins techniques**. (Details of doctoral workshop will be publish soon)



Scope of the 64th ESReDA seminar

The study of the digital transformation in the context of industry and infrastructure is highly topical and interesting. One of the business areas where this transformation is expected to be most significant is maintenance. It is, therefore, important to analyze how maintenance can benefit from this transformation and how to do it: What are the new technologies and tools with the greatest potential impact on maintenance and why? How can this transformation process be mandated and realized? How will emerging asset management platforms, intelligent maintenance Apps, and digital twins technology impact companies?

The advent of new technologies has made the maintenance landscape more intricate, necessitating efficient management of vast information and predictive alarms within dynamic schedules. However, the complexity of optimizing the maintenance decision-making process often hampers the technology's impact on organizations. Consequently, conventional maintenance practices continue to be the norm, leading to a delay in embracing digitalization and hindering the expected return on investment for companies undergoing the digital transformation effort. Overcoming this resistance to change is paramount, especially with the emergence of advanced digitalization approaches like digital twins technology, which introduces a new dimension and a complex System of Systems (SoS) scenario.

Furthermore, the role of individuals in the context of maintenance digitalization of maintenance is critical. Embracing digital transformation offers an opportunity for human evolution, leveraging the expertise and experience of employees in the new digital environment. This, in turn, provides a competitive edge in driving innovation and technological progress.

The challenges become even more significant when considering the transformation of assets or systems with limited digitization. Such assets represent a considerable portion of those amenable to digitization today and often hold valuable knowledge about their degradation and maintenance, typically residing with the personnel responsible for their management. Capturing and transferring this expertise into digital twin systems or intelligent maintenance Apps becomes essential for fully unlocking the potential benefits of digital transformation in maintenance practices as digitalization continues to advance.

This seminar aims to bring together researchers, practitioners, and experts from various disciplines to share their insights and advancements in the realm of digital maintenance and its relationship with digital twins, complex systems, and human resources. The event intends to provide a vision of digital maintenance once the foundational technologies (AI, predictive analytics, digital twins, IoT, cloud/edge/fog computing, etc.) have reached a sufficient degree of maturity. This vision should facilitate drawing conclusions on the approaches needed to overcome current barriers that limit the full development of digital maintenance, particularly in assets and systems with a low level of digitization. During the seminar, participants will have the opportunity to share experiences in applying different technologies to improve maintenance, review the state of the art of these technologies, and evaluate their real impact on organizations and the evolution of their maintenance models..

Topics

We invite researchers and professionals to submit their original and high-quality papers related to the following topics (but not limited to):

1. Current Barriers in Implementing Technologies for Real Maintenance Evolution:

- Identification and analysis of challenges hindering the adoption of digital maintenance technologies.
- Barriers to integrating cutting-edge maintenance practices in traditional industrial environments.
- Case studies highlighting real-world experiences and lessons learned in overcoming barriers.
- Maintenance Modelling: Addressing the significance and challenges of creating comprehensive maintenance models for various assets, exploring approaches to predictive maintenance, failure analysis, and decision-making processes.

2. Advancements of Digital Twins in Complex Systems Generation:

- Digital twins and/or asset administration shell as fundamental components of complex systems in the Industry 4.0 era.
- Challenges and solutions in defining and treating assets within digital twins
- Applications of digital twins in predictive and prescriptive maintenance strategies.
- Integration of IoT, AI, and data analytics for enhancing digital twin capabilities.
- Digital twins and MBSE (Model Based System Engineering).
- Limitations and opportunities of digital twin technology
- Standardization approaches.

3. The Role of Human Resources in the Context of Digital Maintenance and Digital Twins:

- Skill gaps and training requirements for the workforce to embrace digital maintenance.
- Human-computer interaction and collaboration in the digital twin environment.
- Strategies for upskilling and reskilling the maintenance workforce for the digital era.

Domains

- OEM (Original Equipment Manufacturers)
- Power generation & supply
- Process industry
- Gas & Oil production, storage & transport
- ICT networks, data storage & servers
- Transport: rail, road, air and maritime
- Supply chain process
- Water supply, water treatment, and water works

Chairman of the Seminar

- Dr. Aitor Goti, Associate Professor in Department of Mechanical, Design and Industrial Management Maintenance, Universidad de Deusto

Technical Programme Committee (TPC) (To be confirmed and enriched)

Adolfo Crespo	SP	Cyp F.H. van Rijn	NL
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John Andrews	UK	Miguel Ortega	SP
Joaquín Ordieres	SP		

Local Organization Committee (LOC)

For practical local information relative to the venue, please, contact: Aitor Goti (aitor.goti@deusto.es) with Antonio Guillén (ajguillen@us.es) and Mohamed Eid (eid.etudes@gmail.com) in Cc.

Relevant dates

- Submission of abstracts: January 20th, 2024
- Authors notification: February 10th, 2024
- Full papers or extended abstract: March 31th, 2022
- Date of seminar: 30th - 31th May
- ESReDA project group's meetings: 29th May, 2024
- ESReDA Board of Directors meetings: 29th May, 2024
- ESReDA General Assembly: 30th May, 2024
- ESReDA Gala dinner: 30th May, 2024

Procedure to submit an abstract, paper and to register

Authors wishing to present a paper are invited to submit a short abstract (max. 400 words) and author's names online, before 20th December 2023.

The full papers or extended abstracts should be submitted before December 20th and should address the following:

- Objectives;
- Relevance for the Seminar;
- Novelty;
- Data, Methods and findings.

Extended abstracts are an alternative to full papers. An extended abstract should be at least one page in length, and it should include a list of most relevant references (5 or 6). Both extended abstracts and full papers will be published in the JRC technical report.

Proposals should be sent to Aitor Goti (aitor.goti@deusto.es) and Antonio Guillén (ajguillen@us.es)

Registration and Seminar Fee

A registration form and the practical information package will be made available on the ESReDA website. Fees, according to ESReDA's rules, are:

- Speakers : one speaker per accepted paper is exempted.
- ESReDA members : 3 participants/member are taken in charge by the Seminar.
- Others : 300€/participant
- Accompanied persons for Gala dinner: 60€/acc. person.

To be paid by bank transfer to ESReDA account:

Holder : ESReDA
 Bank : BNP Paribas Fortis Bank, Boulevard Jamar 1 D, 1060 Brussels, Belgium
 IBAN : BE69 0012 3728 1678
 BIC : GEBABEBB
 Subject : Registration in the 64th ESReDA Seminar

Seminars Proceedings

The final proceedings of the 64th Seminar will be edited in the form of Technical Report and e-published with public access.

Venue

Faculty of Engineering – University of Deusto, Bilbao Campus



The University of Deusto was inaugurated in 1886. The concerns and cultural interest of the Basque Country in having their own university, as well as the interest of the Jesuits in establishing higher studies in some part of the Spanish State coincided in its conception. Nowadays, Bilbao is the center of a metropolitan area with more than one million inhabitants, a city traditionally open to Europe.

The central headquarters of the University of Deusto is located on the opposite side of the estuary, facing the Bilbao Guggenheim Museum, an emblematic symbol of the significant transformation of Bilbao during the last three decades. In 1916, the “Universidad Comercial de Deusto” received a group of students who would be the first graduates in Economic Sciences in Spain.

The institution is located on two campuses: Bilbao and San Sebastian and headquarters in Madrid and Vitoria. It counts with 10.000 students, 600 professors and 1200 invited professors. As Jesuit University, Deusto is a part of an international network, formed by 202 educational institutions that provide a pedagogical tradition centered on the person as essential value.

How to get to Universidad de Deusto?

[Link](#)

Accommodation

[Link](#)

ESReDA Book Order Form

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* ESReDA Project Group on "Resilience Engineering and Modelling of Networked Infrastructure" has successfully published its final report. The report title is "Modelling the Resilience of Infrastructure Networks", ©2021 by ESReDA, ISBN 978-2-930928-11 (EAN ISBN 9782930928111).

Date

Signature

One copy of each ESReDA report is offered once to each ESReDA member and co-author for free otherwise the participation in the edition-costs is 90€.

Delivery costs by the ordinary postal services in the EU continental zone is included in the announced contribution. For different zones, estimated additional fees should be expected for the postal transport.

Please send your book order form to: Antonio Jesus Guillen (ajguillen@us.es), with Siegfried Eisnger (siegfried.eisinger@dnv.com) and Micaela Demichela (micaela.demichela@polito.it) in Cc.