European Safety and Reliability Association

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Newsletter June 2024

Editorial

Michael Beer
Chair

Edoardo Patelli
Vice-Chair

Maria Chiara Leva
Treasurer

Myrto Konstantinidou,
General Secretary

The first half of 2024 has been quite busy with several exciting developments in ESRA, and the success of another ESREL conference.

A big thanks to the organizers of ESREL 2024 for their hard work and to the participants for their valuable contributions, excellent presentations and vivid discussions on important and emergent topics. The conference proceedings have been collected into ESREL 2024 Monograph Book Series. available from the ESREL 2024 website, https://www.esrel2024.com.

The next ESREL conference will be held in Stavanger, Norway, 15-19 June 2025. The conference is organized in collaboration with the Society for Risk Analysis Europe (SRA-E), providing a great opportunity to extend our network. All the information regarding the submission, accommodation, organization of special session can be found on the conference website https://esrel2025.com.

We like to plan ahead, and we are pleased to announce the ESREL 2026 will be held at the University of University of Minho, Portugal 14-19 June 2026. We are also announcing the first ESREL World Conference that will be held at Chongqing University, China in April 2027. So block your calendar. The ESREL World Conference is not a replacement of the annual ESREL conference, in fact we are looking candidatures for organizing ESREL in 2027, possibly in September. Please contact us if you would like to discuss this opportunity.

We are also updating the Article of the Associations (bylaws) in order to comply with the new Belgian Companies and Associations Code. This gives us the opportunity to modernize and improve the Associations bylaws. All the major modifications have been approved by the General Assembly on the 24 June 2024 but the final modification to the Article of the Association needs to be approved by the Extraordinary General Assembly, planned for the beginning of September 2024. Check our ESRA website for a detail explanation of the new Article of the Association.

So far, 20k Euros have been allocated to support activities proposed by our members. Such activities include training courses, workshops, seminars and conferences.

We are also pleased to announce that we have provided support for travel and attending ESRA-related activities to 10 PhD students so far. A new PhD travel support call will be released also in September 2024.

A total of 50k euros are expected to be used to support ESRA activities in 2024. This has been made possible by the incomes generated by the ESREL conferences in 2022 and 2023.

Please consider the further dissemination and promotion of results and activities from ESREL and ESRA by publishing contributions in our ESRA Newsletter, publishing extended papers in the journals related to ESRA and guest-edit Special Issues in those journals. Note that the Journal "Reliability Engineering and System Safety" is published in association with ESRA.

The positions of Chairperson, Vice-Chair and Treasurer have been renewed for two more years during our last General Assembly. Thank you to all the ESRA members for the support.

We thank you very much for your valuable contributions and initiatives and wish you a well-deserved summer break.

Michael Beer, Chair
Edoardo Patelli, Vice-Chair
Maria Chiara Leva, Treasurer
Myrto Konstantinidou, General Secretary

Feature Articles

Accounting for the unexpected: the latent failure probability – A concept developed by Professor André Beck

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Ensuring that the impact of uncertainty is carefully and systematically considered in the practical design of structures and systems is of utmost significance. Indeed, uncertainties regarding material properties, environmental loads and construction methods may severely affect the system's performance and eventually lead to failure. Therefore, in a practical design context, it is necessary to consider and quantify the effects of uncertainty, such that safety of the system's stakeholders is warranted. For such a purpose, engineering design codes typically include safety factors and prescribe load combinations to ensure that structures have adequate margin of safety against uncertainties. These factors and combinations are derived from statistical analyses of historical data and expert judgment to account for variability in loads, material properties, and other parameters. This offers a principled and systematic approach and has been widely accepted by the engineering community. However, the integrity of structural systems relies not only on technical aspects but also on a myriad of nonstructural factors encompassing social, organizational, and behavioral elements. These factors encompass various aspects such as construction methodologies, human error, and misuse of systems, to name a few. Collectively, these non-technical factors introduce considerable epistemic uncertainty, which poses challenges in structural design. However, the question arises: how can we incorporate these non-technical factors into our considerations?

Professor André Beck from the University of Sao Paulo (Brazil) has proposed and developed the concept of latent failure probability [1] that precisely addresses this issue. In a nutshell, his proposal involves augmenting nominal member failure probabilities of a system, derived from objective aleatory uncertainty (that account for technical factors), with latent failure probabilities. These latent probabilities encapsulate subjective estimates reflecting non-technical factors and epistemic uncertainties. The determination of latent failure probabilities is based on a comprehensive risk analysis conducted by the analysis team, including both technical and non-technical considerations. The significance of latent failure probabilities in probability-based design and optimization of structures has been demonstrated in Professor's Beck work, underscoring the need to account for subjective epistemic uncertainties pertaining to non-technical factors. In fact, by considering and including the concept of latent failure probability, traditional reliability-based design methods can produce optimal designs of systems with redundancy, not solely to mitigate objective aleatory uncertainties in loads and material strengths, but primarily to address the profound impact of subjective epistemic uncertainties associated with non-technical factors. Thus, the reliability of a system can only surpass the threshold limited by latent failure probabilities when the system attains redundancy at an optimal level.

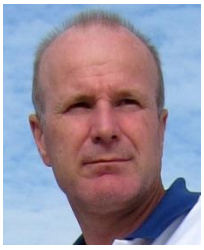
The application of the latent failure probability concept as explored by Professor Beck extends to the optimal design of truss and frame structures [1], with a meticulous consideration of progressive collapse phenomena. His work underscores the practical utility of the latent failure probability concept as a pivotal tool in achieving robustness and redundancy within reliability-based and risk-based structural optimization frameworks. By systematically accounting for the influence of non-structural factors, this approach facilitates the enhancement of structural resilience and reliability, thereby strengthening the integrity of engineered systems against unforeseen challenges.

Professor Beck delivered an ESRA Webinar on the concept of latent failure probabilities on February 2nd 2024. The full lecture is available online at this link:
https://esra.website/news-events/detail-view?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=49&cHash=998d2e10d06adabfa3c0ba1eaf5d3a81

References

[1] A.T. Beck, L.A.R. da Silva, and L.F.F. Miguel, "The latent failure probability: A conceptual basis for robust, reliability-based and risk-based design optimization," Reliability Engineering & System Safety, vol. 233, p. 109127, 2023, https://doi.org/10.1016/j.ress.2023.109127.

Seminar on Reliability of Future Power Systems



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Introduction

Electric power system is a complex system, which is regularly changed: by new power plants added or old removed, by new power lines added or old upgraded, by update of the technical rules for transmission system operator, by update of the technical rules for distribution system operator, by changes of other components, by changes of rules of operation or market requirements [1, 2, 3].
Its reliability is difficult to measure by one parameter value, so rather several indices and measures are defined for assessment of its reliability.
Electric energy supply at home is an issue, which now offers more solutions than years ago. Years ago we had concentrated electric energy generation and a small number of large plants: nuclear, hydro, thermal and some others. Now we have more and more dispersed electric energy generation and a large number of small plants (in addition to some large conventional plants).
Self-sufficient electric energy supply is a term, which implies that all electric power is generated by own sources. Although, many sources define a self-sufficient electric energy supply as a term which implies that only a part of electric power is generated by own sources, which is more a partial self-sufficient than a self-sufficient supply is generated by own sources.
Seminar on reliability of future power systems focused on self-sufficient power supply for a family house and its costs compared to classical power system reliability costs.

Method

Mathematical model includes [4]:
- evaluation of electric energy generation from solar power plant,
- assessment of electric energy consumption at every time step,
- evaluation of electric battery as an energy storage and its state of charge,
- equality of electric power generation and consumption at every time step,
- definition of system reliability,
- optimization of costs of energy generation from solar power plant and from batteries.

Evaluation of electric energy generation from solar power plant depends on:
- number of photovoltaic modules and their size, which gives the total surface of solar power plant,
- efficiency of solar power plant,
- weather parameters measured through density of solar radiation for a specific location of specific house,
- time steps (their duration and their number), which normally model one-year period (8760 hours).

Assessment of electric energy consumption depends on:
- number of electric power consumers (electric appliances) and their power and their timing of operation,
- time steps (their duration and their number), which normally model one-year period.

Evaluation of electric battery as an energy storage and its state of charge takes into account the capacity of battery, which needs to cover the electric energy consumption, when solar power plant is not operating or it is not operating with enough power to cover the consumption.
Definition of system reliability requires that all time points are assured with required energy, so all electric energy consumption is assured from own supply.
Definition can be understood close to the definition of loss of load, as theoretically set to zero.
Size of battery has to be so large, that the state of charge of battery at any time would not go below zero considering the consumption and solar power plant production.
Optimisation of costs of energy generation from solar power plant and from batteries requires:
-data related to costs of solar power plants depending on its size,
-data related to costs of batteries depending on its size and
-optimisation algorithm.

Results

The specific model for specific location includes the yearly data about density of solar radiation, the yearly prediction of timely curve of home consumption and a starting date.
Consumption is assumed the same in every year considered. Home consumption is assessed including deterministic assessment of home consumers and some random part, because we cannot model exactly the real time consumption through the year.
Several locations and several years of those locations have been modelled.
Photovoltaic power plant production varies hourly and daily and yearly according to the weather conditions, so a slightly smaller or larger battery is needed in some year and the same is for the photovoltaic power plant size, consequently.
Every location differs from another, and every year differs from another.
Results on Figure 1 show how the larger photovoltaic power plant depends on the need for smaller battery and vice versa. Larger solar power plant requires smaller battery and vice versa.

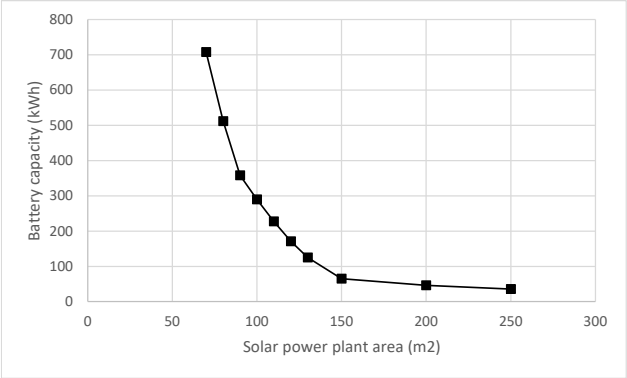
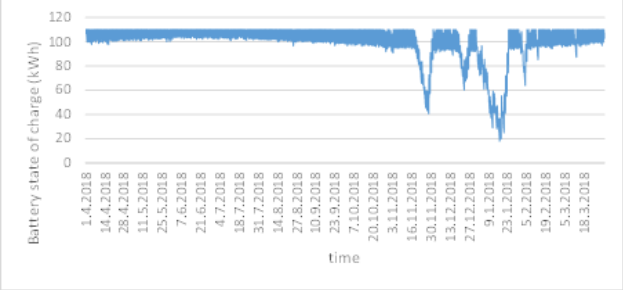


Figure 1: Solar power versus battery capacity for a family house for a self-sufficient electric energy supply.

Figure 2 shows the state of charge of battery at Bežigrad in the year 2018 (battery capacity 110 kWh, photovoltaic power plant size 150 m2 with efficiency of 20 %.). At the end of the winter, the battery is the least full. For conservation of the battery it is modelled, that it cannot be emptied more than to 20% of its capacity. This is due to the fact that the lifetime of the battery is reduced, if the battery is fully discharged. This is specially true if the empty battery time duration is longer.



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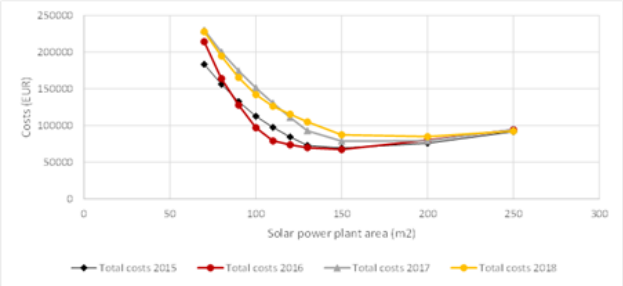

Figure 3: Cost optimisation in consecutive years for a specific location of family house with solar power plant and battery.

Figure 3 shows cost optimisation in consecutive years for a specific location of family house with solar power plant and battery. Years vary related to hours and distribution of solar irradiation.
More results are shown in references [4, 5].

Conclusions

The self-sufficient power supply may be significantly more expensive compared to the costs of the current home power supply with the classical electric power system.
Variations between specific years can be easily 20 % different from other years in terms of higher or smaller costs due to weather variability (more or less sunny hours).
Conservatism is needed for maintaining reliability of self-sufficient supply.
A different location with more Sun, contributes to decreased costs.
The reliability of a family house connected to the distribution power system may be significantly larger than the reliability of house not connected to the distribution power system [4].

Acknowledgements

Support from European Safety and Reliability Association for a Seminar on future power systems is acknowledged (Ljubljana, Slovenia, 22. 11. 2023).

References

1. Čepin M., Assessment of power system reliability, Springer, 2011.
2. Bricman Rejc Ž., Čepin M., Estimating the additional operating reserve in power systems with installed renewable energy sources, International journal of electrical power & energy systems, 2014, vol. 62, str. 654-664.
3. Čepin, M., Špelko A., Glaser B., Reliability of power system in Slovenia - comparison of scenarios. 30th International Conference Nuclear Energy for New Europe: September 6-9, Bled, Slovenia, Proceedings, Nuclear Society of Slovenia, 2021, 502(p.1-8).
4. Čepin M. Costs optimisation of reliable self-sufficient electric energy supply at family house. Reliability engineering & systems safety, May 2023, Vol. 233, 109105.
5. Čepin, M. Reliability and costs of conventional electric power supply versus self-sufficient supply, Invited lecture (scheduled for ESREL 2024, Wroclaw).

Digital Twins for safety analysis, risk assessment and emergency management

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1. Introduction

Digital Twins (DTs) can support decision making and control by mirroring products and services, creating virtual copies of complex systems through the integration of real-time data, modeling and simulation techniques [1]. DTs can leverage not only the safety analysis and risk assessment of complex systems, but also provide insights for a risk-informed decision-making process during accidents and emergencies, performing timely control actions by mimicking the system dynamics through a digital replica [2]. Despite the wide variety of research works and case studies (see [3]), there is a gap regarding security and risk associated to the use of DTs in the industry. Aspects such as standardization, communication and data management protocols, cybersecurity and lifecycle persistence are just some of the open issues that need to be addressed, especially for the application of DTs in risk assessment and emergency management of safety-critical systems and crisis situations, respectively [4,5]. In this regard, in [3] we have presented a critical review of the development and use of DTs for safety analysis, risk assessment and emergency management. The study has focused on the latest advancements, and highlighted the pending challenges and limitations for the practical deployment of DTs in practice.

2. Digital Twins

Most of the conceptual models for DTs are composed of three essential entities: the physical object (PO), the digital object (DO) and the twinning parts, including the virtual-to-physical (V2P) and the physical-to-virtual (P2V) twinning processes (see Fig. 1). As stated in the first conceptual model proposed by Grieves [6], the ideas that gave rise to DTs are not new: what is new is the scale, complexity and non-deterministic nature of the models, which can actually produce a closed feedback loop between the PO and the DO, allowing automated control actions and assistance during emergencies and accidents [1].

In [3], we have conducted a Systematic Literature Review (SLR) of journal papers published between 2018 and 2023. Utilizing a semi-automatic approach [7], the review process has been aimed at extracting cases of implementation and use of DTs for safety analysis, risk assessment and emergency management applications. The methodological framework adopted to select the papers comprised five pivotal research questions (RQs), specifically the expected functions (RQ1), implementation techniques (RQ2), model representations (RQ3), twinning processes (RQ4), and challenges within the specified application domains (RQ5).

3. Findings

Here, we offer a summary of the findings from the study (see Fig. 2), in relation to the specific RQs addressed:

3.1 RQ1: Expected tasks and functions

DTs are deployed for a variety of tasks or functions across different application domains. In safety analysis applications, DTs have been used to calculate safety influencing factors, assess safety performance, and identify hazardous effects and accidents. In risk assessment

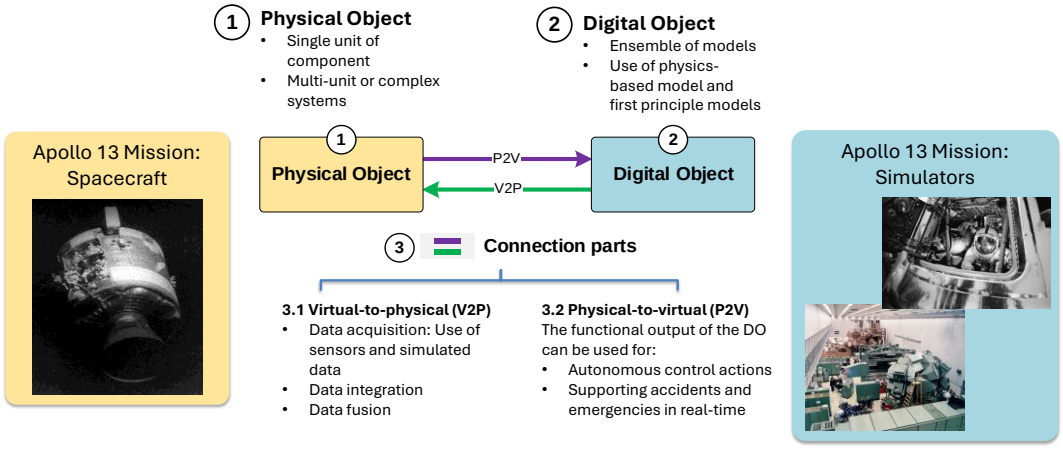

Figure 1. Conceptual model of Digital Twins. Adapted from [9]

applications, most of the DT-based methods have been proposed for risk identification, quantitative risk assessment, risk monitoring and prognostics. In emergency management applications, DTs have been applied to

enhance real-time guidance during accidents and to provide real-time support to safety management in emergency situations.

3.2 RQ2: Techniques and approaches
The study has revealed a range of techniques and approaches for implementing DTs. In safety analysis applications, most of the selected works have proposed the integration of physics-based models (e.g., geometric models, mechanical models) and data-driven models, giving rise to grey-box or hybrid modeling approaches [8]. In risk assessment, most of the case studies have revealed the use of hybrid modeling, combining ML techniques with physics-based simulations. A similar approach has been exploited in emergency management applications, focusing on physics-based models, underlining the role of virtual reality and ML for real-time guidance and early warning systems.

3.3 RQ3: Model representation types
Several model representation types have been employed to capture the complexities of the twinning processes in safety analysis and risk assessment applications, including geometric models, physics-based simulations and data-driven algorithms. The integration of these modeling techniques allows DTs to address the complexity of the systems and data handling. Regarding emergency management applications, the studies have mainly relied on similar model representation types, enhancing the efficacy and timeliness of contingency strategies and control actions.

3.4 RQ4: Twinning process
The twinning process is one of the fundamental aspects of DTs, as it allows the seamless integration and communication feedback between the PO and the DO. This process encompasses data management, communication protocols and connectivity, which are critical for the successful use of DTs. The most relevant findings are summarized as follows:
- Data management: The reviewed case studies have emphasized the essential role of data collection, integration and assimilation. In most cases, these tasks are supported by wireless sensors and IoT-based devices to gather real-time data from the physical environment. The integration of these devices requires platforms such as BIMs that can handle and analyze vast amounts of collected data, ensuring that the DT mimics the current state of the PO.
- Communication and connectivity: Effective communication channels and connectivity protocols are keys for the real-time exchange of data between the PO and DO. Most of the case studies highlight the use of wireless networks and IoT-based communication infrastructures as key enablers for this purpose. These technologies facilitate the seamless flow of data, which is necessary for the dynamic updating of DTs and the implementation of control actions.

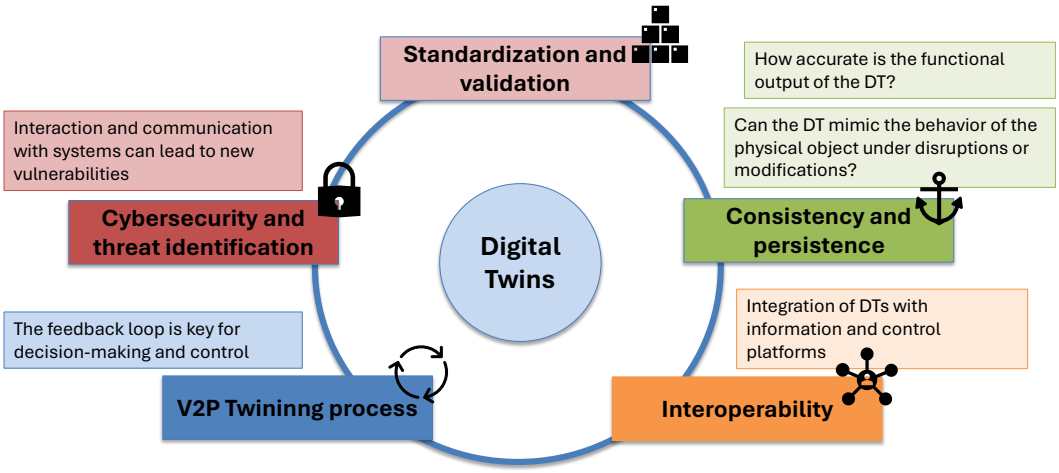

Figure 2. Summary of challenges for the implementation of Digital Twins. Adapted from [3]

3.5 RQ5: Limitations and challenges
The most relevant challenges extracted from the literature review are related to the following topics:
- Uncertainty quantification: The selected cases have revealed a lack of tools and techniques for quantifying the uncertainty of the models within the digital layer. Uncertainty quantification is fundamental for providing reliable predictions and decisions based on the functional outputs of the DT, especially in applications involving safety and risk assessment.
- Consistency and persistence: The consistency between the DO and the PO poses a significant challenge, especially during unexpected system disruptions or operational anomalies. For long-term applications, it is crucial to ensure the accuracy and functionality of DTs over the lifecycle of the PO. Achieving consistency and persistence requires robust modeling techniques and real-time data integration.
- Standardization and interoperability: The performed literature review has revealed a lack of standardization in the development and implementation of DTs. Standard protocols and formats are needed to ensure interoperability and seamless integration with existing infrastructures and systems. This includes the standardization of data formats, communication protocols and model representations, to facilitate an effective deployment of DTs.

- Cybersecurity and threat identification: It is important to identify potential vulnerabilities to cyber threats and analyze the cybersecurity of DTs, given the complexity of the digital layer and its integration with existing systems.

4. Conclusions

This brief contribution shares some main findings obtained from a systematic literature review of DTs for safety analysis, risk assessment and emergency management. The reader can find the extensive analysis in [3]. The advancements in real-time emergency and risk assessment demonstrate the benefits of using DTs. However, several challenges must be addressed to leverage the capabilities of DTs for practical application. Key challenges include data fusion and reconciliation to ensure accuracy and reliability, explainability and uncertainty quantification techniques to make DTs trustworthy. The integration of DTs with existing systems is also a pending challenge that can be achieved by establishing standardized reference models and protocols, which will enhance their interoperability. Consistency analysis of DT models can ensure that DTs evolve with their physical counterparts, remaining accurate over their lifecycle. Lastly, a comprehensive safety analysis and threat identification will be essential to mitigate potential security risks, ensuring the robustness and integrity of DTs.

References

[1] Jones D, Snider C, Nassehi A, Yon J, Hicks B. Characterising the Digital Twin: A systematic literature review. CIRP J Manuf Sci Technol 2020;29:36–52. https://doi.org/10.1016/j.cirpj.2020.02.002.

[2] Bevilacqua M, Bottani E, Ciarapica FE, Costantino F, Donato L Di, Ferraro A, et al. Digital twin reference model development to prevent operators' risk in process plants. Sustainability 2020;12:1–17. https://doi.org/10.3390/su12031088.

[3] Zio E, Miqueles L. Digital twins in safety analysis, risk assessment and emergency management. Reliab Eng Syst Saf 2024;246:110040. https://doi.org/10.1016/j.ress.2024.110040.

[4] Boyes H, Watson T. Digital twins: An analysis framework and open issues. Comput Ind 2022;143:103763. https://doi.org/10.1016/j.compind.2022.103763.

[5] Shaikh E, Al-Ali AR, Muhammad S, Mohammad N, Aloul F. Security Analysis of a Digital Twin Framework Using Probabilistic Model Checking. IEEE Access 2023;11:26358–74. https://doi.org/10.1109/ACCESS.2023.3257171.

[6] Grieves M, Vickers J. Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems. Transdisciplinary Perspectives on Complex Systems, Cham: Springer International Publishing; 2017, p. 85–113. https://doi.org/10.1007/978-3-319-38756-7_4.

[7] van Dinter R, Tekinerdogan B, Catal C. Predictive maintenance using digital twins: A systematic literature review. Inf Softw Technol 2022;151. https://doi.org/10.1016/j.infsof.2022.107008.

[8] Pintelas E, Livieris IE, Pintelas P. A Grey-Box Ensemble Model Exploiting Black-Box Accuracy and White-Box Intrinsic Interpretability. Algorithms 2020;13. https://doi.org/10.3390/a13010017.

[9] Grieves M. Digital Twin : Manufacturing Excellence through Virtual Factory Replication - A Whitepaper by Dr . Michael Grieves. White Paper 2004;1:1–7.

ESRA News

Special Sessions of the ESRA Technical Committee on Security

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The objective of the Technical Commission on Security (TCS) is to contribute to the exchange of experiences in dealing with problems related to ensuring capabilities to prepare for, adapt to, withstand and recover from dangers and crisis caused by deliberate, intentional, malicious acts of people, such as terrorism, sabotage, organized crime or hacking. All those interested in this area of expertise are invited to join the TCS.

Recently, the activities of the TCS have been focused on the ESREL 2024 conference in Krakow, for which it has prepared two special sessions.

The first is entitled Assessment of Physical Protection Systems and will feature a total of three contributions focusing on selected aspects of physical protection of people and objects. A collective of authors from the Institute for Security Systems of the University of Wuppertal has prepared a brief summary of the results of their research in the area of security measure robustness analysis with respect to epistemic uncertainty when examining possible scenarios leading to security breaches. The contribution describes a conceptually novel approach to security measure analysis that respects the limited information that is typically available about possible security breach scenarios. The second paper, prepared by a team of authors from the Faculty of Security Engineering of the University of Zilina, evaluates the possibilities of using a system of monitoring and tracking of people in the framework of physical protection. This issue is very topical, because the current development of the use of artificial intelligence dramatically increases the effectiveness of the monitoring and tracking systems. The last paper in this section is devoted to the problem of soft targets protection and was prepared by experts of the Faculty of Applied Informatics of the Tomas Bata University in Zlin. The paper provides a comprehensive overview of current trends and latest experiences in soft

targets protection and deals with realistic possibilities of soft targets protection.

The second prepared special section is a monothematic one dedicated to the presentation of the results of the LIFE SECURDOMINO project, coordinated by the University of Pisa. The project is funded by the European Union and has been running since 2021 and, despite the fact that its completion is only planned for the next calendar year, a number of interesting results of the project are already available. Chemical and petrochemical sites, energy facilities, oil and gas installations, and more in general, industrial facilities storing relevant quantities of hazardous substances are characterized by a potential for severe environmental disasters when affected by external acts of interference. Indeed, physical attacks trough explosions, shooting, vandalism, etc. or cyber-attacks trough sabotage of process control systems may trigger complex cascading effects and the consequent release of large amount of flammable, explosive, toxic, or noxious substances in the environment. Also, domino effects are likely, due to multiple, simultaneous scenarios triggered by the propagation of accidents from the attacked units to the rest of the plant. Accidents caused by security-related threats and domino effect in the process industry may affect coasts, rivers, lakes, and densely populated urban areas at regional and national scale. The project explores these criticalities and proposes advanced tools for integrated safety-security assessment dedicated to process facilities. The proposed special session investigates the recent advances in the framework of these topics and presents the methods and tools developed among the project. The following presentations are part of the special section programme (the name of the presenter and affiliation is in brackets).

•Development of advanced tools for safety-security integration based on the implementation of site-specific protections (Gabriele Landucci - University of Pisa).

•Integration of safety and security aspects in the EU context: comparative analysis of legislative frameworks (Sanneke Kuipers - Leiden University)

•Real-time three-dimensional safety-security assessment of process facilities in critical areas (Dino Dentone - Datach Technologies S.R.L.)

•Maghreb as a critical area for the oil/gas facilities in the security context: the Algeria case study (Francesco Tamburini - University of Pisa)

Conference Report: The International Conference on Information and Digital Technologies (IDT 2023)

Elena Zaitseva, University of Zilina, Slovakia

The International Conference on Information and Digital Technologies (IDT 2023) was held on 20-22 June 2023 in Zilina (Slovakia). The Conference IDT 2023 (https://idt.fri.uniza.sk/) was organized in cooperation of the University of Žilina and European Safety and Reliability Agency (ESRA). It is one of the famous events in the Visegrad region in the reliability engineering domain because the Workshop on Reliability and Safety is an integral part of this conference.

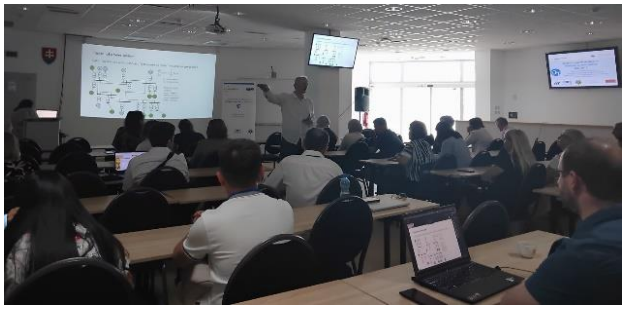
The main workshop's objectives were (a) the establishment of collaboration between the target groups: young researchers, academic teachers, and representatives of enterprises in the reliability engineering area; (b) the discussion of the modern trends and teaching aspects in the reliability engineering. Important participants were young researchers and PhD students who obtained invitations to participate in this event. The workshop focused on various problems of Reliability and Safety, such as Human Factor and Human Reliability, Mathematical Methods in Reliability and Safety, Safety and Risk Assessment, System and Structural Reliability, Software Reliability and Testing, Survival analysis, Quantitative Risk Assessment, and Uncertainty Analysis.

On the whole, we have obtained more than 80 submissions. The submissions have been reviewed by members of the Program Committee and external experts. The organizational team would like to thank all of them for their contribution to the improvement of the quality of the accepted presentations and papers. 42 of these submissions were selected to publish in the Conference proceedings that were indexed in well-known scientific repositories, such as Scopus and IEEEExplorer.

More than 60 participants attended the Conference and about 30 joined online. All presentations were reviewed by

at least two experts similar to the published papers. The approved presentations were organized into 3 plenary sessions and 12 working sections. These presenters created a very creative and productive atmosphere for participants of the plenary and working sessions and during the breaks. In the plenary sessions, distinguished invited speakers gave a review of the future perspectives in their research areas including safety management, reliability, information technologies, and medical informatics. In particular, the following invited lectures were delivered by the speakers:

- Data-driven decision making in practice: Experiences in academia and government – Dr. Martin Komenda from Masaryk University (Institute of Health Information and Statistics), Brno, Czech Republic
- Self-sufficient electric energy supply at home – prof. Marko Čepin from University of Ljubljana, Slovenia;
- Benefits of Petri nets for systems modeling and probabilistic assessment in reliability engineering – prof. Nicolae Brinzei, University of Lorraine, France;
- Multi-Diagnosis Cough Classification Evaluation – prof. Martin Lukac, Hiroshima City University, Japan;
- Maintenance optimization of complex multi-component systems – prof. Radim Briš, VSB-Technical University of Ostrava, Czech Republic.



The organizing committee prepared also several cultural and social events that were held in a pleasant atmosphere. Participants of the workshop visited the famous Bojnice Castle. The castle is now an important center of recreation and tourism located in the center of Slovakia, which benefits from its rich historical heritage. Similar cultural event support to establish personal contacts between teachers and young researchers, to organize team-building with a kindly atmosphere.

We are going to organize the next IDT Conference in 2025. Our organizational team will be glad to deepen cooperation with IEEE Czechoslovakia Section Reliability Society, and ESRA. New ESRA members are welcome to become a part of the program committee.

PhD Theses

Physics-based Guided Wave Structural Health Monitoring, and its Integration in Asset Management Modelling

Wen Wu
University of Nottingham
UK

In February 2024, Mr. Wen Wu from the University of Nottingham in the UK, successfully defended the thesis "Physics-based Guided Wave Structural Health Monitoring, and its Integration in Asset Management Modelling".

The supervisor team included Dr. Rasa Remenyte-Prescott and Dr. Darren Prescott (University of Nottingham) and Dr. Dimitrios Chronopoulos (KU Leuven). The project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No. 859957.

Thesis summary

Structural health monitoring (SHM) plays a vital role in ensuring the integrity of engineering infrastructures. Its primary objective is the implementation of a systematic approach to detect and identify potential damage or structural issues within these assets. By incorporating the identified information about asset condition from a monitoring system, engineers can utilise asset management models to manage maintenance activities in order to lower operating and maintenance costs and increase the life of these assets. The main aim of this thesis is to develop efficient damage identification methods using ultrasonic guided waves and integrate them with asset management modelling approaches.
Firstly, a physics-based Bayesian frameworks using a guided waves interaction model for damage identification of plate is proposed, as shown in Figure 1. A semi-

analytical approach based on the lowest order plate theories is adopted to obtain the scattering features for damage geometries. The proposed framework can identify the geometry of a partly through-thickness circular hole in plate-like structures and reconstruct scattering field. Compared with a traditional finite element model and similar methods, this approach results in an efficient inversion procedure for damage size identification [1,2].

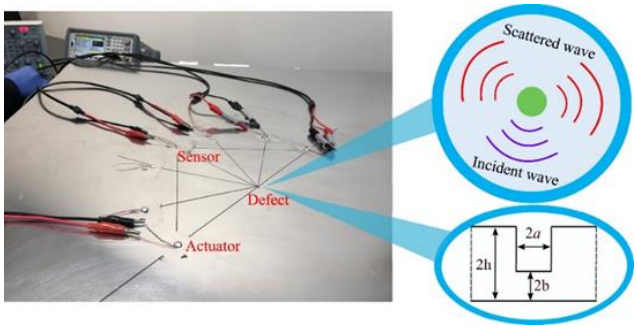


Figure 1 Ultrasonic guided waves propagation and interaction scheme

Next, a general framework is developed to evaluate the SHM reliability that takes into account sensor failures. The framework involves modelling the degradation process of sensor networks using Petri nets and calculating the expected information gain of the sensor network based on the information theory. The proposed framework is able to estimate monitoring performance, including monitoring accuracy and uncertainty, of the monitoring system throughout its operational time. Importantly, this approach can be potentially extended to assess the reliability of various monitoring systems, particularly those vulnerable to sensor failures [3].

Leading Edge (LE) erosion causes reduced power output and a reduction in efficiency by impairing the aerodynamics of the blade. In severe cases, it can reduce the structural integrity of the blade. In addition, it is hard to forecast the evolution of a LE erosion defect, and to make prioritization of damages across a fleet of wind turbines. The approach proposed in this paper combines a Bayesian updating and physics-based model with the aid of drone inspection failure data to predict the future evolution of LE erosion. The method, based on the Bayesian updating method, can capture complex interactions in the degradation process. The physics-based approach can reflect physical degradation mechanisms. Fusion of knowledge from physics-based predictive models with information mined from failure databases using Bayesian updating can combine advantages of the two methods [4].

Finally, a wind turbine blade asset management Petri net model is proposed, covering failure, state discovery and repair strategy processes, as shown in Figure 2. The model can forecast the future blade condition for a given asset management strategy, taking into account detailed industry guidelines. Besides, it investigates the impact of the monitoring system reliability on the asset management modelling results. The simulation results illustrate the degree of uncertainty introduced into the monitoring results by the reliability of the monitoring system and, consequently, the extent to which this factor influences the maintenance strategies [5].

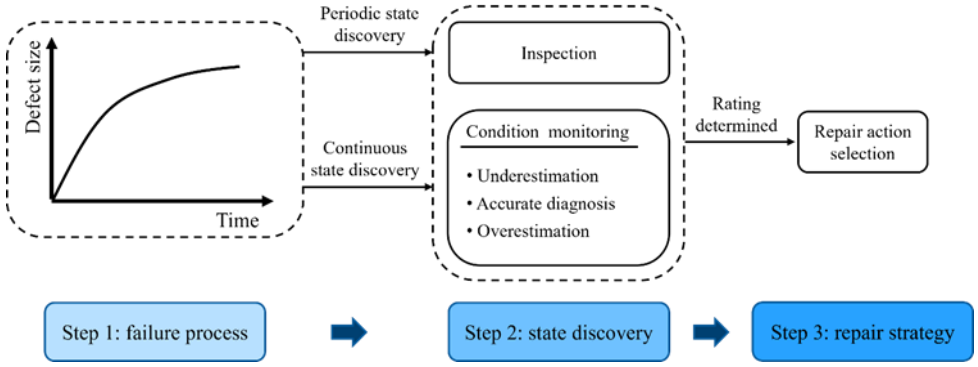


Figure 2 Overview of the workflow of wind turbine blade asset management

References

[1] W. Wu, M. K. Malik, S. Cantero-Chinchilla, T. Lawrie, W. J. Yan, G. Tanner, R. Remenyte-Prescott, D. Chronopoulos. Guided waves-based damage identification in plates through an inverse Bayesian process. Ultrasonics, 2022: 106773 (https://doi.org/10.1016/j.ultras.2022.106773).

[2] W. Wu, S. Cantero-Chinchilla, W. J. Yan, M. Chiachio Ruano, R. Remenyte-Prescott, D. Chronopoulos. Damage Quantification and Identification in Structural Joints through Ultrasonic Guided Wave-Based Features and an Inverse Bayesian Scheme. Sensors, 2023, 23(8): 4160 (https://doi.org/10.3390/s23084160).

[3] W. Wu, S. Cantero-Chinchilla, D. Prescott, R. Remenyte-Prescott, M. Chiachio Ruano. A general approach to assessing SHM reliability considering sensor failures. Reliability Engineering & System Safety (under review), 2023.

[4] W. Wu, S. Naybour, R. Remenyte-Prescott, D. Prescott. A physics-based leading edge erosion growth prediction model utilizing Bayesian updating and drone-inspection data. Renewable Energy (under review), 2024.

[5] W. Wu, D. Prescott, R. Remenyte-Prescott, A. Saleh, M. Chiachio Ruano. An asset management framework for wind turbine blades considering reliability of monitoring system. Reliability Engineering & System Safety (under review), 2023.

Calendar of Safety and Reliability Events

RECI 2024, 3rd International workshop on Reliability Engineering and Computational Intelligence, Zilina, Slovakia, 6 - 8 November 2024. The Workshop focuses on all areas of synergy between two scientific domains which are reliability engineering and computational intelligence. The participation of students, PhD students and younger researchers is welcome (online participation is free of charge). https://reci.fri.uniza.sk/.

ESREDA 65th Seminar "From risk imagination to safety intervention: managing risks with knowledge", Athens, Greece, 14-15 November 2024. NCSR Demokritos with ESReDA's 'Risk, Knowledge, Management' (RKM) project group organise the 65th ESReDA seminar to foster an exchange of ideas and expert on the intricate relationships between risk, knowledge and management, aiming to find new ideas for preventing accidents and improving safety management with better utilisation of knowledge. Abstract submission until the 14th of July at https://easychair.org/conferences/?conf=65thesredaseminar . ESRA members may participate to this event free of charge as ESRA is sponsoring the seminar. More details at the ESREDA webpage: http://www.esreda.org/ and https://inrastes.demokritos.gr/news_cpt/4803/.

The 6th Eurasian Conference "Innovations in Minimization of Natural and Technological Risks of Climate Changes: Methodology and Practice", Baku, Azerbaijan, November 19-21, 2024.
Hosted by AMIR Technical Services LLC, jointly organized with Azerbaijan Technical University, International Group on Reliability "Gnedenko Forum" (USA), and Politecnico di Milano (Italy).
The Eurasia Risk platform serves as a recognized hub for intellectual exchange, focusing on minimizing natural and technological risks through innovation. This year's COP-29 side event, "Innovations in Minimization of Natural and Technological Risks of Climate Changes: Methodology and Practice," explores critical risks to socio-technical infrastructures under the global climate agenda, emphasizing the need for interdisciplinary approaches to achieve sustainable development. https://www.eurasianrisk2024.com/.

RAM&PHM 4.0: Advanced methods for Reliability, Availability, Maintainability, Prognostics and Health Management of industrial equipment (XXVI Edition), Milan, Italy, November 18-20, 2024.
The goal of this course is to provide participants with advanced methodological competences, analytical skills and computational tools necessary to effectively operate in the areas of reliability, availability, maintainability, diagnostics and prognostics of modern industrial equipment. The course presents advanced techniques and analytics to improve safety, increase efficiency, manage equipment aging and obsolescence, set up condition-based and predictive maintenance. https://www.corsoram-phm.energia.polimi.it/

8th International Conference on System Reliability and Safety (ICSRS), Catania, Italy, 20-22, November 2024.
The International Conference on System Reliability and Safety (ICSRS) is an annual event that focuses on this important theme. Co-sponsored by the IEEE Reliability Society (Italy Chapter), ICSRS has been held in several major cities including Rome, Paris, Milan, Barcelona, and Venice.
The conference provides a platform for researchers, practitioners, PhD students and industry experts to exchange ideas and present their latest research findings on various topics, including fault diagnosis, fault-tolerant control, risk analysis, safety management, system reliability assessment, and maintenance optimization. https://www.icsrs.org/.

ESRA Information

1. ESRA Membership

Professional Associations

- DBI - The Danish Institute of Fire and Security Technology, Denmark
- ESReDA, France
- IDA Risk – Technical Network for Risk Assessment under the Danish Society of Engineers, Denmark
- KAERI (Korea Atomic Energy Res. Institute), Korea
- NVRB, The Netherlands
- Polish Safety & Reliability Association, Poland
- SINTEF AS, Norway
- The Safety and Reliability Society, UK
- VDI - Society Product and Process Design, Germany
- VTT, Finland

Companies

- BQR Reliability Engineering Ltd., Israel
- DNV, Norway
- EBG MedAustron GmbH, Austria
- Safetec Nordic AS, Norway
- Saudi Aramco, Saudi Arabia
- TNO Research, The Netherlands

Educational and Research Institutions

- Aalto University, Finland
- Aarhus University, Denmark
- Aix Marseille University, France
- Bergische Universität Wuppertal, Germany
- Centrale Supélec, Université Paris Saclay, France
- Chongqing University, China

- City University of Hong Kong, Hong Kong
- Czech Technical University in Prague, Czech Republic
- Durham University, UK
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- Irena Jakopanec

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3. Standing Committees

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The aim of this committee is to establish the general policy and format for the ESREL Conferences, building on the experience of past conferences, and to support the preparation of ongoing conferences. The members are one leading organiser in each of the ESREL Conferences.

3.2 Publications Standing Committee

Chairman: C. Guedes Soares, Instituto Superior Técnico, Portugal
This committee has the responsibility of interfacing with Publishers for the publication of Conference and Workshop proceedings, of interfacing with Reliability Engineering and System Safety, the Journal that is published in Association with ESRA, and of producing the ESRA Newsletter.

3.3 Communications Committee

Chairman: Luca Podofillini - Paul Scherrer Institute, Switzerland.
The purpose of this Technical Committee is to enhance and support the communication and dissemination of information among ESRA members and external stakeholders. The committee is responsible for managing the ESRA website, newsletter, social media and other communication channels. The committee also coordinates with other technical committees to ensure the quality and consistency of the information provided by ESRA. The committee aims to increase the visibility and impact of ESRA's activities and achievements in the field of safety and reliability engineering. The committee welcomes initiatives and suggestions from ESRA members on communication and information sharing. Don't hesitate to contact us in cases of feedback or proposals.

4. Technical Committees

Methodologies

- Accident and Incident Modeling
- Decision Making under Uncertainty
- Foundations of Risk and Reliability Assessment and Management
- Human Factors and Human Reliability
- Maintenance Modeling and Applications
- Mathematical and Computational Methods in Reliability and Safety
    - Simulation for Safety and Reliability Analysis
- Organizational Factors and Safety Culture
- Prognostics and System Health Management
- Resilience Engineering
- Risk Assessment
- Risk Management
    - Economic Analysis
- Structural Reliability Applications
- System Reliability Applications
- Uncertainty Analysis
    - Imprecise Probabilities

Application Areas - Technological Sectors

- Aeronautics Aerospace
- Chemical and Process Industry
- Civil Engineering
- Communications Committee
- Critical Infrastructures
- Energy
- Healthcare and Medical Industry
- Industrial Liaison Committee
- Information Technology and Telecommunications
- Land Transportation
- Manufacturing
- Maritime and Offshore Technology
- Natural Hazards
- Nuclear Industry
- Occupational Safety
- Security

ESRA is a non-profit international organization for the advance and application of safety and reliability technology in all areas of human endeavour. It is an "umbrella" organization with a membership consisting of national societies, industrial organizations and higher education institutions. The common interest is safety and reliability.
For more information about ESRA, visit our web page at https://esra.website
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