European Safety and Reliability Association

Newsletter

http://www.esrahomepage.eu

December 2017

Editorial

Terje Aven
ESRA Chairman
University of Stavanger, Norway

Dear ESRA Colleagues,

The preparation for the ESREL 2018 conference in Trondheim, Norway, (https://www.ntnu.edu/esrel2018) June 17-21 is going well. The Chairman of the conference, Professor Stein Haugen, is reporting that they received more than 700 abstracts by the deadline October 15. The full paper deadline is December 15, 2017. The Proceedings of the conference will be published by Taylor and Francis, and for the first time the papers will be available as Open Access (on the CRC website). This represents a milestone in the ESREL-ESRA history, and I would already like to congratulate the local ESREL organiser for making this possible. It will set the standard for future conferences.

The fifth ESRA webinar was held by Dr. Luca Podofillini on November 29, 2017. The title was: "Humans and Risk, Reliability, Resilience Models". It was a very interesting talk and discussion, see a recorded version at our website esrahomepage.eu. I consider the webinars to have been a success and hope we can continue the series in 2018. They represent an exciting and useful way of communicating and discussing current safety, risk and reliability issues.

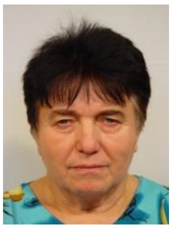
A work has been initiated by the ESRA board, to establish a more updated membership database. The work is led by General Secretary Roger Flage. He will contact all existing members, as well as former members (the last 3-5 years) to bring up to date the membership list. Why support ESRA by being a member is summarized at esrahomepage.eu (join ESRA). I think the essential point is sharing the responsibility for the safety, risk and reliability fields to further develop and grow as sciences and professions. ESRA and ESREL rely on the history and efforts of a number of peoples' commitment to and hard work for these fields, and the continuing success of ESRA and ESREL depends very much on our ability to create new enthusiasm, momentum and drive for these fields. Being a member of ESRA expresses that you find the work associated with ESRA and ESREL valuable and would like to back it. The fee is a symbol; equally important is your support to the ESRA visions and goals, by your willingness to take responsibility and help us develop strong safety, risk and reliability fields. I encourage you all to renew your ESRA membership, and I would like to challenge each and one of you to define the following goal for 2018: Encourage at least one new organization or company to become an ESRA member. If we all succeed on this, or at least 50% do, it will be great. ESRA will grow and its work for safety, risk and reliability can be further developed to the benefits of all of us.

With kind regards,

Terje Aven
Chairman of ESRA

Feature Articles

Sources of risks in railway transportation



Dana Prochazkova
Czech Technical University in Prague
Faculty of Transportation Sciences
Praha, Czech Republic

Introduction into problems

From the general view the railway system plays very important role in terms of transportation in the European area. The transportation mode is widely used not only for middle and long-distances, but it has also very important role in short distances between small agglomerations and for the public transport in cities. Therefore, the safety of railway system has long-term tradition as well as railway operating itself since twenties 19th century.

Although the railway safety has the long tradition, the number of requirements on safety and their depths are increasing because the increase of population density and vulnerability of environ, in which the railway system operates. Especially, in the European railway system the requirements on interoperability are very important [1].

Because the social phenomena based on human intent were found as the significant threat, the security requirements have been step by step introduced into practice. From the system viewpoint there are other influencing aspects which affect the railway safety, e.g. the interconnection of cyber and physical systems, the human-machine interfaces and overall perceiving and handling with such complex systems, i.e. socio-technological (technical) systems [2]. The practice shows that their violation is often the cause of serious railway accidents, and therefore, we need to protect the railway system against them.

The monitoring of railway system and the critical assessment of previous railway accidents are necessary for understanding the complicated nature of railway system safety, for which reach there are necessary to implement the protective, mitigating, response and renovation measures.

Data and methods used in reveal of sources of risks in railway transportation

For investigation of risks that threaten the railway transportation, the special database of railway accidents was compiled [3]. The database contains two parts. The first one was created for the whole world by help of internet [4]
with using the passwords “rail disasters”, “railway disasters”, “rail accidents” and “railway accidents”, especially from the sources [5–8]. The data on railway accidents are from 1650. It shows e.g.:

-The worst train disaster in the rail history was caused by tsunami on Sri Lanka at December 26, 2004 – the death of over 1700 people,

-The railway accidents often occur in India; the biggest accident was in the State of Bihar in June 6, 1981, it died more than 800 people when passenger train derailed when it had crossing the bridge over the Bagmati River,

-The huge consequences have the railway accidents of freight trains shipping the hazardous substances. The huge railway accidents with presence of hazardous substances was on the January 6, 2005 in the us, Graniteville, South Carolina at which 9 people died, more than 250 people were injured when the freight train collided head-on with a parked local freight train near the Avondale Mills plant in Graniteville. 16 wagons (including a tank car that ruptured 90 tons of chlorine gas into the air) derailed in the accident. The US NTSB determined that the cause of the accident was the failure of the local freight's crew members to realign the switch for mainline operations

-Very great accident of freight train was on the July 6, 2013 in Lac-Mégantic, Quebec, Canada. The freight train containing 72 tank cars of crude oil runs away unattended and derails. Several wagons explode, destroying over 30 buildings in the town's centre, roughly half of the downtown area, and requiring the demolition of all but three of the remainder of the buildings in the downtown area due to contamination by petroleum from the train; these combine to require the evacuation of 2,000 people, a third of the town's population. 42 are confirmed killed, along with 5 missing and presumed dead, making this the fourth-deadliest rail accident in Canadian history.

The second part of database was created on the basis of very detailed data that are given in the database of The Rail Safety Inspection from the period 2006 up to 2015 [9]; it contains 204 special reports on railway accidents in the Czech Republic and in some reports the description of similar accidents that happen in another sites since 2006 and were not often the object of investigation of inspection.

The data on railway traffic accidents in database [3] are judged in the context of integral safety of railway system, i.e. not only from the viewpoint of railway system, but from the human security and development. The data are processed by current statistic methods and by special risk engineering procedures as the CBA, separation of accidents into seven accident sources´ categories, determination of logic interconnections among the accident sources and their expression by fish-bone diagram [10].

Sources of risks in railway traffic

The critical analysis of railway accidents on the basis of data from compiled database revealed the main causes of accidents and near-misses. Due to present situation (e.g. cyber-attacks cannot be excluded) the railway accident sources are in following domains:

-Technical - related to rail traffic vehicles,

-Technical - related to rail infrastructure and railway station,

-Railway operation control - organizational causes,
-Railway operation control - cyber causes,
-Control of rail traffic vehicles,
-Attack on the train,
-Legislative and other.

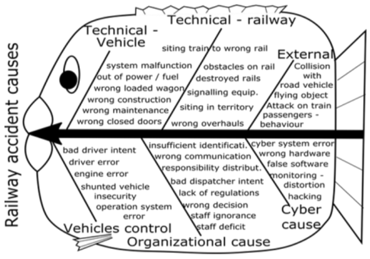


Fig.1. Causes of railway accidents in the Czech Republic.

The fish-bone diagram shows the main categories of railway accident causes; Figure 1. It only contains six main categories of causes. The diagram helps the specialists and the paper readers to in-depth insight into the problem of railway accidents. We see the causes arranged according to affinity, which enables to look up the possible actions, i.e. the measures for railway system safety improvement, for the whole groups of accident causes

Conclusion

The critical analysis of railway accidents revealed that some of accident causes often repeat, e.g. the insufficient maintenance, low-class overhauls and renovation. They have immediate cause that is not the root cause of such accident type; the root cause is often poor safety culture in the sector and deficits in training.

Our research will continue in preparation of real tools for individual sectors of followed domain such as check lists, risk management plans and operational crisis plans for great railway stations, especially those in which the hazardous substances in great amount are present.

References

[1] EU. Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety on the Community's railways and amending Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification (Railway Safety Directive).

[2] D. Prochazkova. *Safety of complex technological facilities.* ISBN: 978-3-659-74632-1. Saarbruecken: Lambert Academic Publishing 2015, 244p.

[3] CVUT. *Archives of data and knowledge on disasters and accidents.* Praha: CVUT

[4] www.google.com

[5] www.railway-technology.com

[6] www.revolvy.com

[7] www.isdo.org

[8] US DOT. *Railway accident reports.*http: //specialcollection.dot.library.dot.gov/Home

[9] Drážní inspekce. Archiv. Praha: http://www.dicr.cz

[10] D. Procházková. Methods, tools and technique for risk engineering. Praha: ČVUT 2011, 369p. ISBN 978-80-01-04842-9.

Robustness requirements for buildings in the Eurocode

Dirk Proske
University of Natural Resources and Life Sciences (BOKU)
Vienna, Austria

Buildings should be robust. They should neither suddenly nor completely fail under beyond design actions. This design requirement can be found in various standards. However, it must also be feasible. Eurocode 0, Section 2 states:

A structure shall be designed and executed in such a way that it will not be damaged by events such as:

explosion, impact, and the consequences of human errors, to an extent disproportionate to the original cause.

This paragraph lists various accidental actions such as explosions and impacts. Other accidental actions are not explicitly mentioned, for example earthquakes and floods. In particular, flooding with all its special effects such as scouring, debris etc. plays a major role in the overall collapse frequency of bridges. It reaches the same proportion as impacts for the overall bridge stock. Flooding is by far the biggest cause of bridge collapses over watercourses. It is therefore astonishing that other accidental actions are not mentioned.

In contrast, impact is explicitly mentioned. Impact is by far the biggest cause of the collapse of bridges spanning roads or railway tracks. The group of impacts can be subdivided into technical, natural and special impacts. Increasingly, all impact actions are normatively prepared and made available such as codes for debris flow impacts (specifically ONR 24801 for debris flow impact or ISO/WD 10252 for Accidental Loads). This makes it possible for the design engineers to consider the impact loads adequately including robustness requirements and considering the high uncertainties of the loads.

In contrast, the above-mentioned general robustness requirements are difficult to implement in day-to-day business without standards. Already today, numerous combinations of actions have to be calculated for the limit state of load bearing capacity and serviceability. A systematic investigation of different structural solutions with regard to robustness beyond design would require further extensive calculations which may only be possible for large structures due to a higher budget.

For these two reasons, the robustness requirement above must be and increasingly is covered by the standards dealing with specific accidental actions.

The consideration of human errors in the design and execution process seems even less helpful. Human errors in a work step cannot be covered by the same work step.

Instead, they must be covered by alternative and additional work steps. This is also the view of

Eurocode 0 itself, which demands proper execution and quality assurance measures in Section 2.2. This section requires:

The reliability required for structures within the scope of EN 1990 shall be achieved:

b) by

– Appropriate execution and

– Quality management measures.

Based on all considerations, a reformulation of the robustness requirements in the Eurocode could be made:

Buildings shall be designed and constructed in such a way that they are not disproportionately damaged by beyond design actions. This applies mainly to accidental loads that are associated with high uncertainties. Human errors in the design, execution and use of structures can only be covered to a limited extend in the design process and must be covered by control and monitoring programs, such as quality controls.

This requirement for robustness is probably more purposeful to achieving the goal of robust structures.

PhD Degrees Completed

Reinforcement Learning for Optimization of Industrial Systems

Enrico Cobelli
Supervisors:
Prof. Enrico Zio
Co-supervisor:
Dr. Ing. Luca Bellani and Dr. Michele Compare
Politecnico di Milano, Italy

Gas Turbines (GTs) are complex systems composed by several expensive capital parts (e.g., buckets, nozzles, shrouds, etc.), which are affected by different degradation mechanisms (e.g., fracture and fatigue, fouling, corrosion, oxidation). Degradation and failures can lead to failures of the GTs, with to costly Forced Outages (FOs). When parts fail, they are scrapped and replaced by parts of the same type available at the warehouse.

To avoid parts failures, GTs are periodically maintained: at every preventive maintenance cycle, the parts are removed from the GTs and replaced by parts of the same type available at the warehouse. The removed parts are scrapped if they have reached their pre-fixed maximum number of working cycles or, otherwise, they are repaired at the workshop and put back in the warehouse, ready to be installed on another GT in the same Oil & Gas plant at one of the next preventive Maintenance Shutdowns (MSs). Thus, at every periodic MS, a decision is made on both the removed part (send it to the workshop for repair or scrap it) and the part to be installed on the GT (new part or one taken from the warehouse). These decisions strongly impact on the profitability of the GT plant operation, depending on both the repair costs and the risk of FOs due to GTs failures: scrapping old parts reduces risk and workshop costs but increases the number of purchase actions. Furthermore, at the end of the GT operational time the warehouse may contain parts available for installation, whose value is lost. Obviously, the parts installed on the GTs will no longer be available at the warehouse for the next MS and even if they are not scrapped, they return to the warehouse with a reduced number of remaining working cycles.

Thus, the decision at every MS modifies the decisions at the next MSs. In this sense, the described GT part flow management can be framed as a Sequential Decision Problem (SDP). From the considerations above, it clearly appears that GT part flow management should seek the best sequence of future maintenance decisions (i.e., the optimal policy) over the GT operation time horizon, rather than greedy decisions with the smallest immediate cost at the next MS. This requires the Decision Maker (DM) to consider many additional variables such as the remaining time up to the end of the GT operational horizon, the availability of spares, the costs related to the repair actions, etc.

Despite the relevance of the part flow management for the Oil & Gas Industry, to the author best knowledge, systemic approaches to address it are still lacking and experienced-based rules are considered as the de facto state of art by the GT plant owners, although it is not proved that they yield optimal policies. Among the experienced-based rules, the Most Residual Cycle (MRC) is one of the most widely adopted in industrial practice: the removed parts are always repaired until the end of the GT plant operational time horizon and the part with the largest residual life among those available at the warehouse is installed on the GT; a new part is purchased only when the warehouse is empty. This way, MRC ensures the smallest repair cost at the smallest failure probability.

In the framework proposed here, GT part flow has been formulated as a SDP, first deterministic and, then, stochastic to account for the failure behaviour of the capital parts. RL has been chosen as solving technique. In the deterministic SDP settings, it is shown that RL finds part flow policies with maintenance costs smaller than those derived from the experienced-based rules (i.e., MRC) classically adopted in practice. Moreover, the case study shows that the optimal maintenance policy found by RL strongly depends on the initial warehouse composition and the length of the operational time horizon, which makes not possible to identify a set of general rules that can be followed and applied by plant owners.

This result implies that the optimal part flow policy can be found only by running a part flow simulator including the RL framework proposed here.
In the stochastic SDP setting, RL again finds a more efficient part flow policy than MRC: it increases the GTs reliability by increasing of roughly 1% the number of episodes without FOs and it outperforms the MRC policy decreasing the mean total maintenance costs.
As conclusions, we can conclude that, the framework adopted in the deterministic setting is immediately extendible to part flow simulators, which deal with capital parts that are unlikely to fail, leading to a sensible maintenance costs reduction. On the other hand, if parts failure is a matter of interest to the plant owner, the framework applied in the stochastic setting cannot be immediately extended to a real industrial case scenario, because the computing time would be too long due to the domain size, which drastically increases.
To address this issue, future research could investigate the feasibility of coupling RL with neural networks, also known as value function approximation method.

Markov Decision Process (MDP) Framework for Optimal Operation and Maintenance of Industrial Systems Equipped with Prognostic Capabilities

Paolo Marelli
Supervisor:
Prof. Piero Baraldi
Co-supervisor:
Dr. Michele Compare,
Prof. Enrico Zio
Politecnico di Milano, Italy

In the last decades, energy systems, such as energy production plants, power transmission grids or gas distribution networks, have been evolving to adapt to the increasing market demand. This has led to the development of complex structures, where the use of multiple components arranged in different architectures is mandatory to perform the intended function (e.g. deliver electricity or gas to the users of the network) in the most safe and reliable way, while also ensuring a high-quality level of service.
Furthermore, the volume of data and information collected from energy systems through the use of condition monitoring sensors has grown exponentially and more sophisticated and performing analytics have been developed to exploit them. In particular, Prognostics and Health Management (PHM) systems have been developed for the detection of failures, the identification of their causes (diagnostics) and the estimation of the Remaining Useful Life (RUL) of the most critical components constituting the systems (prognostics).
However, a general framework that allows for a comprehensive management of energy systems, i.e., one which takes into account the diverse aspects that are involved (degradation state of the components, user demand levels, degradation state estimation errors, maintenance decisions, management decision effects, system architecture reconfiguration possibilities) is still lacking.
Against this backdrop, we developed decision-support frameworks based on Markov Decision Processes (MDPs) and Partially Observable Markov Decision Processes (POMDPs) for the optimal operation and maintenance management of modern industrial systems with PHM equipped components. These frameworks enable a comprehensive approach to the operations management of industrial systems, encoding realistic degradation state estimations provided by the PHM systems, while considering the context changes and the effects of the management decisions on the network degradation evolution.
Specifically, MDPs consist of a 5-tuple (S, A, T, R, γ), each element corresponding to one of the problem variables. In details, S, the set of states, encodes the degradation state of the components; A, the set of actions, specifies all the available actions for the management of the system; T, the transition probability function, defines the probability of entering a new state after the execution of an action; R, the reward function, states how incomes/losses are obtained from performing actions; finally, γ is a discount factor. The use of MDPs is justified by their mathematical structure that allows solving problems with large dimensionality at a small computational effort. Yet, this advantage comes at the cost of a modeling of the management problem that does not match a realistic setting: in fact, in a MDP framework, the components degradation states are assumed to be perfectly known, i.e., PHM systems do not make misclassification errors. Then, to account for the uncertainty of the PHM system outcome, i.e. the assessment of the component degradation state, MDPs must be converted into POMDPs, which enable the modeling of the estimation errors, at the cost of a solution to the problem which requires a larger computational effort. This is done by introducing additional elements to the mathematical structure of MDPs. In details, the addition of Ω, the set of observations, which includes the possible degradations state outcomes given by PHM systems, and O, the emission function, which relates the observations to the states, to the MDP framework yield a POMDP.
MDPs and POMDPs have been used optimize the operation and maintenance management of two different industrial systems.
First, we dealt with a Multi-Component System (MCS) made up of two pumps arranged in a parallel configuration, which must supply a minimum flow rate to not incur into penalties. In this setting, we assumed that the manager of the system was able to identify the degradation state of the two pumps without any uncertainty, so as to model the problem as a MDP.

Then, the second case study developed a decision-support framework based on POMDPs to enable a comprehensive approach to the operation and maintenance management of a Gas Transmission Network (GTN) of the literature. In this framework, we then accounted for realistic degradation state estimations provided by the PHM systems together with the variability of gas demand of the users in the infrastructure and the effects of the management decisions on the network topology. An approximate solution was found to avoid computational burdens. Moreover, the optimal management policy found with imperfect PHM systems is compared with the optimal management policy obtained without degradation state monitoring to show the benefits deriving from the utilization of PHM systems.

Further research work will be aimed at introducing time dependencies to the MDP problem, leading to the adoption of a Semi-MDP (SMDP) framework.

This way, it is possible to investigate a more realistic situation, where a time-dependent demand exists.

Then, the resulting management strategy is strictly bound to the decisional times, so that it is possible to evaluate the impact of the instant at which maintenance is performed and that of the load setting undertaken on the components, as these determine the progression of the degradation mechanisms. Finally, future researches will investigate how to simultaneously take into account both the time dependencies and the uncertainties of the PHM devices as well as that on the demand of the users, as the resulting framework, a Partially Observable Semi Markov Decision Process (POSMDP) leads to a very complex combinatorial explosion.

Acceptable life safety risks associated with the effects of gas explosions on reinforced concrete structures

Ramon Hingorani
Supervisors:
Dr. Peter Tanner
Dr. Carlos Zanuy
Instituto de Ciencias de la Construcción Eduardo Torroja, IETcc-CSIC, Spain
Universidad Politécnica de Madrid, UPM , Spain

Summary

Accidental actions on structures may be characterized as low probability - high consequence events [1]. On one hand, their occurrence during the envisaged design working life of the structure is unlikely. On the other, if not appropriately accounted for, the associated effects on structures might entail significant damage. Since moreover such effects are subjected to high uncertainties, decision-making related to structural safety accounting for accidental actions is generally difficult and prone to be based on irrational grounds. Among such actions, gas explosions still account for a substantial number [7]. Despite the continuous modernization of gas installations and appliances, available statistics from different countries show that the occurrence rate of such explosions in buildings does not seem to decrease in a significant way. While the hazard potential is known and recognized, and although dealt with in many design codes, gas explosions are seldom accounted for in the design and evaluation of ordinary building structures. The low occurrence probability evokes reluctance to allocate resources to mitigate the associated risks, which, as a consequence, are often ignored and sometimes consciously accepted. The question if "doing nothing" is a justified practice cannot be easily answered however, since under the implicit approach adopted in everyday practice for verification of structural safety the risks are not quantified nor are acceptable risk levels established.

On this background, the PhD thesis [2] aims at exploring methods and tools for the practical application of explicit risk analysis in connection with gas explosions in buildings. Based on previous studies [6], a procedure is established for quantification of implicitly acceptable structure-related risks to persons, based on the probability of structural collapse and the consequences of such a failure in terms of loss of human life. The procedure adopted is applied to a representative set of building structures with RC members (beams and columns), which is obtained by varying the parameters with the greatest effect on design within reasonable limits. Following their identification, the most relevant hazard scenarios to these members are represented in terms of limit state functions (LSF). Based on the established LSF's, a strict design (Ed = Rd) according to a consistent set of codes is carried out, so that structural member performance complies exactly with the safety requirements that reflect current best practice. The basic variables involved in the LSF are stochastically characterized, where special attention is paid to the dynamic effects associated with the explosion-induced high loading rates on the members, such as the contribution of inertia forces, energy dissipation and strain rate-sensitive material behaviour.

Quantification of these effects is addressed in a deterministic dynamic analysis where the explosion load is represented as an idealised pressure-time function, compatible with simplified models. Under consideration of dynamic material properties, member flexural response is obtained assuming a single degree of freedom system, whereas the reaction forces, representative for the shear forces, are determined from the dynamic equilibrium formulation applied to the members themselves. For the beams, a comparative study is conducted, where the deployed simplified models are validated by means of non-linear finite element analysis [3]. The analysis of the columns under dynamic bending moment-axial force interaction requires a specific solution algorithm that accounts for the axial force dependent formulation of structural resistance under consideration of both the material- and geometrical non-linearities involved.

In the subsequent reliability analysis of the structural members, the mentioned algorithm is coupled to a purpose-developed FOSM-based iterative procedure in order to obtain the most likely failure point for the established LSF.

Taking account of the occurrence probability of a gas explosion event, implicitly acceptable structural failure probabilities for both columns and beams are derived and analyzed in the light of target ceilings demanded by structural codes. The findings suggest significant scope for a more rational formulation of design rules for accidental situations related to gas explosions [4].

For the estimation of the structural failure consequences, a regression model is developed from previously compiled and statistically evaluated data on explosion-induced structural collapse scenarios in buildings [5]. The model delivers estimations for the number of fatalities as a function of the area affected by structural collapse (Acol) and the occupancy rate of this area. Reasonable hypothesis are adopted in order to account for the possibility of system collapse given a local member failure.

Subsequently, the implicitly acceptable risks for each of the defined representative building structures are deduced, where account is taken of the fact that, in addition to the considered accidental load scenarios, certain member failure modes might be triggered by persistent load arrangements, associated with normal building use conditions. Acceptance criteria for structure-related life safety risks are deduced from the findings [5]. Such criteria facilitate the adoption of rational decisions on both, the need and the appropriate choice of risk-reduction measures to counteract the effects of gas explosions in buildings. The design of key elements, upon which depends the stability of the structure, or a large part of it, may be one of these strategies. For this purpose, acceptable risks are translated into conditional target failure probabilities pft|EX for individual structural members (given the occurrence of an explosion event). These target values are defined as a function of the potential failure consequences, in Fig. 1 represented in terms of area Acol.

In spite of their notional character, the obtained results provide a rational basis for the calibration of the implicit rules in structural codes and standards for verification of structural safety in relation to gas explosions.

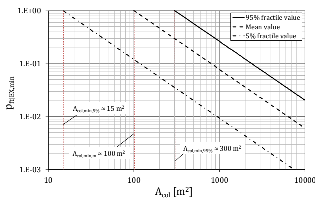
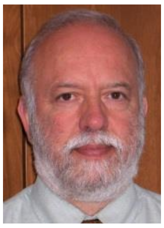


Fig.1. Minimum target value for conditional failure probabilitiy, pft|EX

References
[1] Ellingwood BR. Mitigating Risk from Abnormal Loads and Progressive Collapse. Journal of Performance of Constructed Facilities. 2006;20.
[2] Hingorani R. Acceptable life safety risks associated with the effects of gas explosions on reinforced concrete structures: Universidad Politécnica de Madrid (UPM); 2017.
[3] Hingorani R, Tanner P, Hendriks MAN. Validation of simplified models for the analysis of reinforced concrete beams exposed to gas explosions. Engineering for Progress, Nature and People; 2014. p. 293-300.
[4] Hingorani R, Tanner P, Sánchez CZ. Reliability of RC members submitted to gas explosions. IABSE Congress Stockholm, 2016: Challenges in Design and Construction of an Innovative and Sustainable Built Environment; 2016. p. 447-55.
[5] Hingorani R, Tanner P, Zanuy C. Structure-related life safety risks associated with accidental explosions in buildings. 15th International Probabilistic Workshop. Dresden; 2017.
[6] Tanner P, Hingorani R. Acceptable risks to persons associated with building structures. Structural Concrete. 2015;16:314-22.
[7] Vrouwenvelder T, Leira B. Probabilistic modelling of internal gas explosions. Joint Workshop of COST Actions TU0601 and E55. Ljubljana, Slowenia; 2009.

RESS News



Carlos Guedes Soares
Editor-in-Chief RESS
Instituto Superior Técnico, Universidade de Lisboa

During last trimester the three issues of RESS all contained a special section or a special issue. Volume 166 included the section on Reliability and Performance of Multistate Systems edited by Gregory Levitin and Liodong Xing with 16 papers.

Vol 167 had the special section of Application of Probabilistic Graphical Models in Dependability Diagnosis and Prognosis guest edited by Phillipe Weber and Luigi Portinale with 5 papers.

The special issue on Maintenance Modelling, guest edited by Shaomin Wu and Phuc Do has been published in Volume 168. This is a relatively large issue with 32 papers and 360 pages.

RESS is continuing an active policy towards having special sections or special issues on specific topics so as to present a more focused view on them.

Recently closed special sections, which will be shortly appearing on the web site are:

Games and Decisions in Reliability and Risk
Guest Editors: Refik Soyer and Suleyman Ozekici

Complex Systems RAMS Optimization: Methods and Applications
Guest Editors: David W. Coit, Enrico Zio

Impact of Prognostics and Health Management in Systems Reliability and Maintenance Planning
Guest Editors: Joo Ho Choi and Ming Zuo

The special issue of ESREL 2015 is open for submissions since April 2017:

Foundations and Novel Domains for Human Reliability Analysis
Guest Editors: Luca Podofillini and Ali Mosleh

ESRA News

Continuing education course: "RAM&PHM 4.0: Advanced methods for Reliability, Availability, Maintainability, Prognostics and Health Management of industrial equipment"

October 9-12, 2017

Politecnico di Milano

Author: Francesco Di Maio

The 2017 professional one-week training course: "RAM&PHM 4.0: Advanced methods for Reliability, Availability, Maintainability, Prognostics and Health Management of industrial equipment" took place at Politecnico di Milano, Milan (Italy) on October 9-12. The course was the XX edition of the series. Its goal has been 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 industrial equipment. The course presents advanced analytics to improve safety, increase efficiency, manage equipment aging and obsolescence, set up condition-based and predictive maintenance.

Since the beginning, the course has been officially supported by ESRA and since 2005 official scholarships have been offered. The 2017 edition of the course has been supported by ESRA with two scholarships covering the registration fee. The 2017 scholarships have been offered to two PhD students, one of Politecnico di Torino (Torino, Italy) and the other of the China University of Petroleum (Beijing, China).

The first part of the course is devoted to the presentation of advanced methods for the availability, reliability and maintainability analysis of complex systems and for the development of Prognostics and Health Management (PHM) and Condition-Based Maintenance (CBM) approaches. In this respect, the basics of Monte Carlo Simulation, nonlinear regression and filter models (Artificial Neural Networks, Principal Component Analysis, Auto-Associative Kernel Regression, Ensemble Systems, Hilbert Huang and Wavelet transforms) and evolutionary optimization methods (Genetic Algorithms) are illustrated. In the second part of the course, exercise sessions on Monte Carlo simulation, Artificial Neural Networks and Genetic Algorithms provide the participants with the opportunity of directly applying the methods to practical case studies. Finally, in the last part of the course, real applications of the advanced methods illustrated in the course are presented. The applications range from the evaluation of maintenance costs taking into account the reliability and availability of equipment, to the application of Monte Carlo Simulation for system availability analysis and condition-based maintenance management, to the use of regression and classification techniques
for fault detection, classification and prognosis in industrial equipment.

The 2018 edition of the course fill take place at Politecnico di Milano, Milan (Italy) on November 2018.

Past Safety and Reliability Events

Reliability and Maintenance 4.0: the present future of industry development

October 12, 2017

Politecnico di Milano

Authors: Francesco Di Maio – Piero Baraldi

On 12 October 2017, at Politecnico di Milano, a seminar was held on the topic of " Reliability and Maintenance 4.0: the present future of industry development". The event has been organized by IEEE Reliability (ITALY CHAPTER), Joint IEEE Industry Applications Society, Power Electronics Society and Industrial Electronics Society (NORTH ITALY CHAPTER), Politecnico di Milano, Chair on Systems Science and the Energy Challenge (Ecole Centrale Supelec), European Safety and Reliability Association (ESRA) Technical Committee on Prognostics and System Health Management, and ARAMIS Srl.

As the digital, physical and human worlds continue to integrate, the 4th industrial revolution, the internet of things and big data, the industrial internet, are changing the way we design, manufacture, deliver products and services.

In this fast-pace changing environment, the attributes related to the reliability of components and systems continue to play a fundamental role for industry. On the other hand, the advancements in knowledge, methods and techniques, the increase in information sharing and data availability, offer new opportunities of analysis and assessment for reliability engineering. Based on this increased knowledge, information and data available, we can improve our reliability prediction capability. Particularly, the increased availability of data coming from monitoring the relevant components and systems parameters and the grown ability of treating these data by intelligent algorithms capable of mining out information relevant to the assessment and prediction of their state, has open wide the doors for Prognostics and Health Management (PHM) and predictive maintenance in many industrial sectors, for improved operation and maintenance.

This workshop provided a forum for sharing professional experience and competence at the forefront of the developments in the above themes. Industrial and academic experts will join forces to advance the state of work.

Calendar of Safety and Reliability Events

Welcome to ESREL 2018

Trondheim, Norway

17-21 June 2018

The annual European Safety and Reliability Conference ESREL is an international conference under the auspices of the European Safety and Reliability Association (ESRA).

The topic for ESREL 2018 is “Safe Societies in a Changing World” and our ambition for the conference is to advance in the understanding, modeling, and management of the complexity of the risk, safety and reliability fields characterizing our world, now and in the future. We aim at setting up a multidisciplinary platform to address the technological, societal and financial aspects of these fields. With the support of NTNU, we engage in broadening the scope of risk, safety and reliability from the technical to natural, financial and social aspects, focusing on Inter-dependencies of functions and cascade of failures in complex systems.

The time for the conference is 17-21 June 2018. The conference venue will be at the main campus of the Norwegian University of Science and Technology, NTNU.

<u>Organisers:</u>

Conference General Chairman:

Prof. Stein Haugen – NTNU

<u>Conference Co-Chairs:</u>

Prof. Jan Erik Vinnem– NTNU

Prof. Trond Kongsvik– NTNU

Prof. Anne Barros – NTNU

<u>Important dates</u>

- Abstract deadline: October 15, 2017
- Abstract approval: October 17, 2017
- Full paper deadline: December 15, 2017
- Registration Opening: January 2018
- Comments from reviewers: February 1, 2018
- Final paper: February 15, 2018

Conference Website:

https://www.ntnu.edu/web/esrel2018/home

37th International Conference on Ocean, Offshore and Arctic Engine-ering (OMAE2018) Symposium on Structures, Safety and Reliability

Madrid, Spain

17-22 June 2018

Since 2003, the OMAE conference has more than tripled in size, with over 1,000 participants at OMAE 2015 in St. John’s, Canada and over 900 in Busan, Korea.

The annual OMAE conference is an international assembly of engineers, researchers, and students in the fields of ocean, offshore and arctic engineering. The conference is organized by thematic area in 9 traditional Symposia, one of which deals with topics of Safety and Reliability as applied to this industrial domain. This Symposium typically has around 120 papers and thus is an interesting venue for reliability specialists that want to develop applications in this industrial sector.

<u>Important Dates:</u>

- Abstract submission: October 3, 2017
- Full paper deadline for review: January 12, 2017

<u>Organisers:</u>

<u>Conference Chairs:</u>

Dr. Antonio Souto-Iglesias– UPM (Spain)

Dr. Raúl Guanche García– UC (Spain)

Dr. Francisco Huera-Huarte– URV (Spain)

<u>Technical Program Chair</u>

Dr. Solomon C. Yim – OSU (USA)

Specific questions can be addressed to the **Symposium Coordinator** at:

c.guedes.soares@centec.tecnico.ulisboa.pt

Conference Website: <u>http://www.omae2018.com</u>

OMAE 2018 Madrid

37th International Conference on Ocean, Offshore and Arctic Engineering Madrid, Spain, June 17-22, 2018

16th International Probabilistic Workshop (IPW2018)

Vienna, Austria

12-14 September 2018

It is a pleasure to invite you to the 16th edition of the International Probabilistic Workshop (IPW2018), which will take place from **12 to 14 September 2018** at the **University of Natural Resources and Life Sciences Vienna (BOKU)**, in the beautiful city of Vienna (Austria). This edition of IPW will follow the traditional organization of a multi-disciplinary forum for the exchange of knowledge and expertise, in probabilistic methods, uncertainty quantification, safety and risk management, enabling constructive and fruitful discussions. The event is aimed at specialised developments in both theory and practice with respect to probabilistic methods for engineering purposes. Industry and academia are invited to contribute and to join in the discussions on developments and needs in the field. The conference is intended for mechanical, civil and structural engineers and other professionals concerned with components, structures, systems or facilities that require the assessment of safety, risk and reliability. Participants could therefore be consultants, contractors, suppliers, owners, operators, insurance experts, authorities and those involved in research and teaching.

<u>Important Dates:</u>

- Submission Abstract: February 15, 2018
- Submission Full Paper: April 15, 2018
- Submission Final Paper: May 31, 2018

<u>Organisers:</u>

Local organizing committee:
A. Strauss, Vienna, Austria
K. Bergmeister, Vienna, Austria
E. Apostolidi, Vienna, Austria
E. Kamper, Vienna, Austria
Further information:
Eftychia Apostolidi & Evelin Kamper
Tel.: +43 1 47654-87516
E-mail: ipw2018@boku.ac.at
IPW2018 Website:
http://probabilistic.boku.ac.at/index.html

ESRA Information

1. ESRA Membership

1.1 National Chapters

- French Chapter
- German Chapter
- Italian Chapter
- Polish Chapter
- Portuguese Chapter
- Spanish Chapter
- UK Chapter

1.2 Professional Associations

- The Safety and Reliability Society, UK
- Danish Society of Risk Assessment, Denmark
- SRE Scandinavia Reliability Engineers, Denmark
- ESReDA, France
- French Institute for Mastering Risk (IMdR-SdF), France
- VDI-Verein Deutscher Ingenieure (ESRA Germany), Germany
- The Netherlands Society for Risk Analysis and Reliability (NVRB), The Netherlands
- Polish Safety & Reliability Association, Poland
- Asociación Española para la Calidad, Spain

1.3 Companies

- TAMROCK Voest Alpine, Austria
- IDA Kobenhavn, Denmark
- VTT Industrial Systems, Finland
- Bureau Veritas, France
- INRS, France
- Total, France
- Commissariat á l'Energie Atomique, France
- DNV, France
- Eurocopter Deutschland GMbH, Germany
- GRS, Germany
- SICURO, Greece
- VEIKI Inst. Electric Power Res. Co., Hungary
- Autostrade, S.p.A, Italy
- D'Appolonia, S.p.A, Italy
- IB Informatica, Italy
- RINA, Italy
- TECSA, SpA, Italy
- TNO Defence Research, The Netherlands
- Dovre Safetec Nordic AS, Norway
- PRIO, Norway
- SINTEF Industrial Management, Norway
- Central Mining Institute, Poland
- Adubos de Portugal, Portugal
- Transgás - Sociedade Portuguesa de Gás Natural, Portugal
- Cia. Portuguesa de Producção Electrica, Portugal
- Siemens SA Power, Portugal
- ESM Res. Inst. Safety & Human Factors, Spain
- IDEKO Technology Centre, Spain
- TEKNIKER, Spain
- CSIC, Spain
- HSE - Health & Safety Executive, UK
- Atkins Rails, UK
- W.S. Atkins, UK
- Railway Safety, UK
- Vega Systems, UK

1.4 Educational and Research Institutions

- University of Innsbruck, Austria
- University of Natural Resources & Applied Life Sciences, Austria
- AIT Austrian Institute of Techn. GmbH, Austria
- Université Libre de Bruxelles, Belgium
- University of Mining and Geology, Bulgaria
- Czech Technical Univ. in Prague, Czech Republic
- Technical University of Ostrava, Czech Republic
- University of Defence, Czech Republic
- Tallin Technical University, Estonia
- Helsinki University of Technology, Finland
- École de Mines de Nantes, France
- Université Henri Poincaré (UHP), France
- Laboratoire d'Analyse et d'Architecture des Systèmes (LAAS), France
- Université de Bordeaux, France
- Université de Technologie de Troyes, France
- Université de Marne-la-Vallée, France
- INERIS, France
- Fern University, Germany
- Technische Universität Muenchen, Germany
- Technische Universität Wuppertal, Germany
- University of Kassel, Germany
- TU Braunschweig, Germany
- Institute of Nuclear Technology Radiation Protection, Greece
- University of the Aegean, Greece
- Universita di Bologna (DICMA), Italy
- Politecnico di Milano, Italy
- Politecnico di Torino, Italy
- Universita Degli Studi di Pavia, Italy
- Universita Degli Studi di Pisa, Italy
- Technical University of Delft, The Netherlands
- Institute for Energy Technology, Norway
- Norwegian Univ. Science & Technology, Norway
- University of Stavanger, Norway
- Technical University of Gdansk, Poland
- Gdynia Maritime Academy, Poland
- Institute of Fundamental Techn. Research, Poland
- Technical University of Wroclaw, Poland
- Instituto Superior Técnico, Portugal
- Universidade de Coimbra, Portugal
- Universidade Nova de Lisboa - FCT, Portugal
- Universidade de Minho, Portugal
- Universidade do Porto, Portugal
- University Politechnica of Bucharest, Romania
- University of Iasi, Romania
- Slovak Academy of Sciences, Slovakia
- University of Trencin, Slovakia
- University of Ljubljana, Slovenia
- Asociación Española para la Calidad, Spain
- PMM Institute for Learning, Spain

- Universidad D. Carlos III de Madrid, Spain
- Universidad de Extremadura, Spain
- Univ. de Las Palmas de Gran Canaria, Spain
- Universidad Politecnica de Madrid, Spain
- Universidad Politecnica de Valencia, Spain
- Institute de Matematica y Fisica Fundamental (IMAFF), Spain
- University of Castilla-La Mancha, Spain
- Luleå University, Sweden
- World Maritime University, Sweden
- Institut f. Energietechnik (ETH), Switzerland
- Paul Scherrer Institut, Switzerland
- City University London, UK
- Liverpool John Moores University, UK
- University of Aberdeen, UK
- University of Bradford, UK
- University of Salford, UK
- University of Strathclyde, Scotland, UK

1.5 Associate Members

- Federal University of Pernambuco, Brazil
- Fluminense Federal University, Brazil
- Pontifícia Universidade Católica, Brazil
- European Commission - DR TREN (Transport and Energy), in Luxembourg
- Vestel Electronics Co., Turkey

2. ESRA Officers

Chairman

Terje Aven (terje.aven@uis.no)
University of Stavanger, Norway

Vice-Chairman

Radim Bris (radim.bris@vsb.cz)
Technical University of Ostrava, Czech Republic

General Secretary

Roger Flage (roger.flage@uis.no)
University of Stavanger, Norway

Treasurer

Piero Baraldi (Piero.baraldi@polimi.it)
Politecnico di Milano, Italy

Past Chairman

Enrico Zio (enrico.zio@polimi.it)
Politecnico di Milano, Italy

Chairmen of the Standing Committees

Antoine Grall, University of Technology of Troyes, France
C. Guedes Soares, Instituto Superior Técnico, Portugal

3. Standing Committees

3.1 Conference Standing Committee

Chairman: A. Grall, University of Tech. of Troyes, France
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 Sup. 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 ESRA Technical Journal, and of producing the ESRA Newsletter.

4. Technical Committees

Methodologies

4.1 Accident and Incident modelling

Chairman: Stig Johnsen, Norway & Nicola Paltrinieri, Norway
E-mail: Stig.O.Johnsen@sintef.no; nicola.paltrinieri@ntnu.no

4.2 Economic Analysis in Risk Management

Chairman: Eirik B. Abrahamsen, Norway
E-mail: eirik.b.abrahamsen@uis.no

4.3 Foundational Issues in Risk Assessment and Management

Chairman: Terje Aven, Norway & Enrico Zio, France
E-mail: terje.aven@uis.no; enrico.zio@ecp.fr

4.4 Human Factors and Human Reliability

Chairman: Luca Podofillini, Switzerland & Chiara Leva, Ireland
E-mail: luca.podofillini@psi.ch; levac@tcd.ie

4.5 Maintenance Modelling and Applications

Chairman: Christophe Bérenguer, France & Mitra Fouladirad, France
E-mail: christophe.berenguer@grenoble-inp.fr; mitra.fouladirad@utt.fr

4.6 Mathematical Methods in Reliability and Safety

Chairman: John Andrews, UK & Nicolae Brinzei, France
E-mail: John.Andrews@nottingham.ac.uk; nicolae.brinzei@univ-lorraine.fr

4.7 Prognostics and System Health Management

Chairman: Piero Baraldi, Italy & Enrico Zio, France
E-mail: piero.baraldi@polimi.it; enrico.zio@ecp.fr

4.8 Resilience Engineering

Chairman: Ivonne Herrera, Norway & Eric Rigaud, France
E-mail: Ivonne.A.Herrera@sintef.no; eric.rigaud@mines-paristech.fr

4.9 Risk assessment

Chairman: Marko Cepin, Slovenia & Henrik Hassel, Sweden
E-mail: marko.cepin@fe.uni-lj.si; henrik.hassel@risk.lth.se

4.10 Risk Management

Chairman: Lesley Walls, UK & David Valis, Czech Republic & Marcelo Hazin, Brazil
E-mail: lesley@mansci.strath.ac.uk; david.valis@unob.cz; marcelohazin@gmail.com

4.11 Simulation for Safety and Reliability Analysis

Chairman: Nicola Pedroni, France & Edoardo Patelli, UK
E-mail: nicola.pedroni@ecp.fr; edoardo.patelli@liverpool.ac.uk

4.12 Structural Reliability

Chairman: Jana Markova, Czech Republic & Martin Krejsa, Czech Republic
E-mail: jana.markova@klok.cvut.cz; martin.krejsa@vsb.cz

4.13 System Reliability

Chairman: Gregory Levitin, Israel & Serkan Eryilmaz, Turkey
E-mail: gregory.levitin@iec.co.il; serkan.eryilmaz@atilim.edu.tr

4.14 Uncertainty analysis

Chairman: Emanuele Borgonovo, Italy & Roger Flage , Norway
E-mail: emanuele.borgonovo@unibocconi.it; roger.flage@uis.no

Application Areas - Technological Sectors

4.15 Aeronautics and Aerospace
Chairman: Darren Prescott, UK
E-mail: darren.prescott@nottingham.ac.uk

4.16 Chemical and Process Industry
Chairman: Valerio Cozzani, Italy & Gabriele Landucci, Italy & Nima Khakzad, The Netherlands
E-mail: valerio.cozzani@unibo.it; gabriele.landucci@unipi.it; nkhakzad@gmail.com

4.17 Civil Engineering
Chairman: Raphael Steenbergen, The Netherlands
E-mail: raphael.steenbergen@tno.nl

4.18 Critical Infrastructures
Chairman: Giovanni Sansavini, Switzerland & Enrico Zio, France
E-mail: sansavig@ethz.ch; enrico.zio@ecp.fr

4.19 Energy
Chairman: Michalis Christou, Belgium & Mahmood Shafiee, UK
E-mail: Michalis.Christou@ec.europa.eu; m.shafiee@cranfield.ac.uk

4.20 Information Technology and Telecommunications
Chairman: Elena Zaitseva, Slovakia & Ralf Mock, Switzerland
E-mail: elena.zaitseva@fri.uniza.sk; ralf.mock@zhaw.ch

4.21 Land Transportation
Chairman: Olga Fink, Switzerland & Bob Huisman, The Netherlands
E-mail: olga.fink@ivt.baug.ethz.ch; b.huisman@nedtrain.nl

4.22 Manufacturing
Chairman: Benoit Iung, France & François Peres, France
E-mail: benoit.iung@univ-lorraine.fr; francois.peres@enit.fr

4.23 Maritime and Offshore technology
Chairman: Jin Wang, UK & Ingrid B. Utne, Norway & Mario Brito, UK
E-mail: j.wang@ljmu.ac.uk; ingrid.b.utne@ntnu.no; M.P.Brito@soton.ac.uk

4.24 Natural Hazards
Chairman: Pieter van Gelder, The Netherlands & Bas Kolen, The Netherlands
E-mail: p.h.a.j.m.vangelder@tudelft.nl; B.Kolen@tudelft.nl

4.25 Nuclear Industry
Chairman: Sebastian Martorell, Spain & Francesco Di Maio, Italy
E-mail: smartore@iqn.upv.es; francesco.dimaio@polimi.it

4.26 Occupational Safety
Chairman: Ben Ale, The Netherlands & Reniers Genserik, Belgium
E-mail: ben.ale@xs4all.nl; genserik.reniers@uantwerpen.be

4.27 Security
Chairman: Sissel H. Jore, Norway & Zdenek Vintr, Czech Republic & Genserik Reniers, Belgium
E-mail: sissel.h.jore@uis.no; zdenek.vintr@unob.cz; genserik.reniers@uantwerpen.b