European Safety and Reliability Association

Newsletter

http://www.esrahomepage.eu June 2017

Editorial

Terje Aven
ESRA Chairman
University of Stavanger, Norway

Dear ESRA Colleagues,

The major event this year is the ESREL 2017 conference in Portoroz, Slovenia 18-22 June. See http://esrel2017.org. The General Conference Chair is Marko Cepin, University of Ljubljana, Slovenia, and the Technical Programme Committee Chair is Radim Bris, Technical University of Ostrava, Czech Republic. They are doing a great job, and we all look forward to meet at the conference. The place looks spectacular.

ESRA currently has 27 technical committees (TCs), see http://esrahomepage.eu. A work has been conducted to establish updated contact lists for the TCs. The idea is that the TC Chairs can use these for communication purposes related to relevant activities. If you have not yet registered and would like to be informed about TC activities for your areas of interest, please contact the TC Chairs directly.

We also this year provide direct financial support to several initiatives proposed by our members in response to our annual call for project proposals. This year we got an exceptionally large number of applications, which made it clear that we need to develop some more detailed guidelines for how to select the projects to be supported. The topic will be addressed at the coming General Assembly Meeting during ESREL 2017.

Among the initiatives supported can be mention a workshop on reliability technologies within the international conference on digital technologies in July in Zilina (Slovakia); a PhD school on Vulnerability, Risk and Resilience of Complex Systems and Critical Infrastructures, ECP, Paris; a Workshop on Reliability Assessment of Existing, Complex Civil Engineering Structures, TNO, the Netherlands; a Workshop on Virtual maintenance with focus on safety and reliability at Luleå Technical University, Sweden; a training course in November 2017 on advanced methods for reliability, availability, maintenance, diagnostics and prognostics of industrial equipment at the Politecnico di Milano, Italy; the 3rd Computational Reliability Engineering (CRE) Symposium for technical complex products, University of Wuppertal and University of Liverpool; and an international summer school in Poland (SSARS). Congratulations to all and good luck with the activities. We look forward to reading about these events in coming issues of the ESRA newsletter.

Also this year we will carry out an update of the ESRA memberships, and related payments. I hope that you have already ticked off for paid membership fee for 2017. Thanks.

Terje Aven
Chairman of ESRA

Feature Articles

Average and Above Average Risk

J.R.Taylor

Risk analysis has become a standard tool in process plant safety management. The loss of containment frequency data for the calculations for oil, gas and chemical plant, is mostly derived from one source, the North Sea HRDC database which is observational data, with some extensions and interpretation in the OGP release frequency report. Estimated data derived from many sources, including observational and engineering judgement data is available also in the Dutch Purple Book The OREDA and EXIDA databases give frequencies for failure of safety equipment. Using these data, frequencies for different accident types can be calculated. An alternative is to collect accident cases from around the world and divide the number of these by the number of plants. This is possible for a few accident types.

The underlying data for frequency assessment must necessarily be collected from many plants. No single plant can supply enough data to be able to predict with any certainty the frequency of rare accident events, and in many cases there is no data at all in a single plant for some scenarios, or even for some scenario precursors. The data as collected will therefore include variations because of plant variations. Nevertheless it is assumed in virtually all plants are average plants with average risks. The only variations taken into account concern the size, and the number and types of equipment. There are very few analyses that even take into account whether the substances handled are highly corrosive when determining failure rates.

Inspection of actual plants shows that they in no way represent a uniform population. Some are "bad performers", with equipment being operated long past its design life, with little or no safety management, and with minimal maintenance. Some plants even operate with large parts of their control systems failed. In a study of average and bad performer refinery plants, the bad performers were identified as those with several citations for braches of process safety management regulations such as the US regulation 29 CFR Part 1910.119. The average frequency for vapour cloud explosions was found to be 3.4*10-4 per process unit year. For the bad performers the average frequency was found to be twelve times higher. Some plants were found to have had multiple vapour cloud explosions, which, considering the expected number of incidents in normally distributed population with such a low average frequency, is a clear indication that there are at least two populations.

There are also high integrity plants. These have policies which emphasise safety. They have an organisation which is able to implement that policy, including safety professionals and a commitment to safety by operations and safety staff. They have a full programme of safety training, safety critical systems monitoring and maintenance, emergency procedures and training and continued efforts in work safety management and process safety management. They have an audit system which ensures that the safety efforts are performing according to policy.

It was possible to study major accident frequencies for ten "high integrity" companies over a period of 15 years. Surprisingly, the frequencies of major hazards accidents, and the associated fatal accident rates, were only slightly less than average. The pattern of accidents though was very different from those for average plants. There was only one "ordinary" major accident, of the type typically covered by QRA procedures. The rest were unexpected "black swan" type events.

What does this mean for risk analysis? If we are looking at the risk for an entire (large) country, the presence of a few bad performers will raise the average risk a little. Regulating risk reduction efforts on the basis of average risk will not be a cause for concern. A moderate effort will ensure that the average levels of risk meet acceptability criteria. However some locations may suffer an extremely high risk, much higher than the average and the goal of reasonable levels of safety for all will not be met. Also the risk analyses will tend to hide the problem. Areas with a higher frequency of accidents will just appear as a statistical fluctuation.

This is not just an academic problem. Around the world there are industrial areas and companies which do have elevated levels of risk, and in some cases this has led to public reaction.

How should we address the problems of integrity variation and their effects on risk. If we just ignore the issue, some areas will be exposed to excessive risk. A worse effect is that the risk analysis will be used to "prove" that there is no need for risk improvement and to avoid efforts for better safety management.

Researchers and some authorities have at times considered using process safety management audit indices as an input to risk analysis calculation. A method for this is for example included in risk based inspection standard API 581. The approach has not received wide support because the methods of measurement have been too easy to manipulate, and the underlying theory is still under development. Also, authorities have been reluctant to trust results which can change with the next change in management, or from pressure for quarterly profits.

Another approach is to separately regulate a process which forces all plants to reach a good level of safety management. This is the approach taken by the OSHA regulation 29 CFR Part 1910.119 and is the approach behind several voluntary programs such as Responsible Care. From audit reports it can be seen that this works well in many cases. That it also can fail can be seen from many of the accident reports of the US Chemical Safety Board.

A third approach is licensing of operations and maintenance personnel, as is done in the nuclear industry and in air transport.

The important thing to recognise is that in the absence of enforcement of good process safety management, risk analyses will be misleading, and generally catastrophically so.

Another reason for departure from "average risk" is that a plant can simply be unlucky. A single design error, maintenance error or maintenance error can in some cases destroy an entire plant.

Such unexpected "black swan" events are significant if they cause major accidents within the lifetime of the plant. This implies that the major accident frequency for the "unlucky" plant is greater than once per 50 years, representing a spike in the distribution of major accident frequencies.

That these events occur at all is due to the fact that although each is in itself extremely rare, there are so many different possibilities that together they are significant. A problem of such events is that they place a limit on what can be achieved in QRA. A further problem with these rare event types is that we do not at present have methods to deal with them. Black swan events require new measures in design review, construction quality control and in hazard identification.

Prediction of railway track geometry condition for maintenance planning

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Nowadays, railways are experiencing higher demands, which will in turn impose greater demands on railway track performability. Railway track will degrade through aging and usage, will lose its functionality over time, and is subject to failure. Effective maintenance can be employed to compensate for the shortcomings of railway track functionality and reliability.

The defects and irregularities in track geometry are mostly used to represent the quality of the track and to plan track maintenance. For most railway industries, the standard deviation of the short wavelength (3-25 m) longitudinal level defects is the decisive factor in planning maintenance activities[1]. However, isolated defects also should be considered in the evaluation of track geometry condition. The isolated defects are short irregularities in track geometry (for example. 1-3 m) that can dramatically increase the dynamic forces between wheel and rail (See figure 1).

The track geometry degradation characteristics should be kept within specific limits. Tamping is the main maintenance action used to remedy the track geometry condition and keep it within the required limits. The tamping machine arms squeeze the ballast under the sleepers to improve the geometry condition. Prediction of the track geometry condition is an essential prerequisite to plan maintenance activities to keep railway track performance in an acceptable level[2].

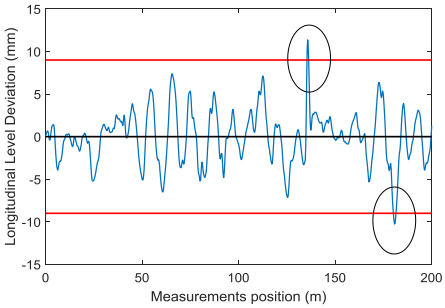

Figure 1. An example of isolated defects in longitudinal level (The blue line is the longitudinal level deviation from mean value and the red lines are maintenance thresholds)

To model the evolution of the geometry condition of a track line, two main challenges must be addressed: modelling the temporal evolution of track geometry condition in multiple maintenance cycles and modelling the spatial variation in degradation parameters. In order to address the two mentioned challenges, A two-level piecewise linear framework is proposed to model the evolution of the track geometry degradation over a spatial and temporal space. In addition, we consider both section based and isolated defects to evaluate and predict track geometry condition over a track line. The model is implemented using a comprehensive case study with data from the Main Western Line in Sweden. The track geometry degradation within one maintenance cycle can simply be modelled using linear or exponential functions. However, tamping usually causes a sudden reduction in the current track geometry level and a change in the degradation rate[3] (See Figure 2).

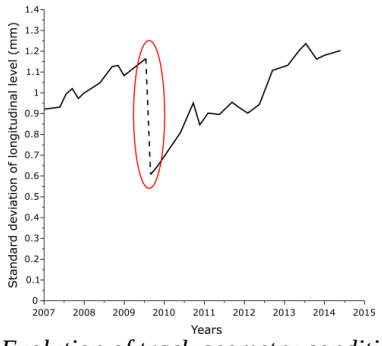

Figure 2. Evolution of track geometry condition
In general, the recovery value after tamping is modelled considering the track geometry condition right before tamping as the dominant factor[3, 4].

However, there is a variation in recovery values even for sections with almost the same track geometry conditions before tamping (See Figure 3).
Therefore, in order to model track geometry evolution in multiple maintenance cycle, a piecewise linear model is proposed in this study. Two multivariate regression models are also used to estimate the recovery value after tamping and change in

degradation rate after tamping. The proposed multivariate models link the two regression lines before and after tamping intervention. By obtaining more information about tamping process and maintenance history, more explanatory variables can be considered in the model to increase the model accuracy.

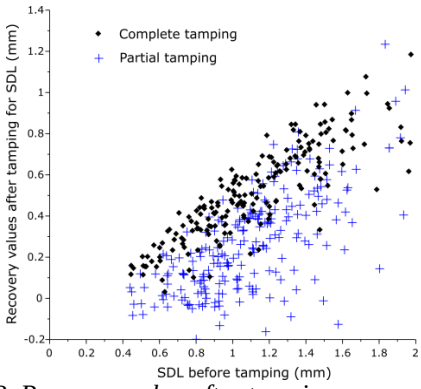

Figure 3. Recovery value after tamping

The results show that, generally, tamping increases the degradation rate. However, the degradation rate after tamping is highly dependent to degradation rate before tamping. Considering the spatial issues, the degradation patterns vary from section to section. It must be noted that the neighbouring track sections often tend to exhibit a more similar degradation pattern than track sections with a significant distance between them. In this study, ARMA models are used to capture the possible spatial dependence structures within the degradation parameters of different sections. To test the goodness of fit of the models, we apply the Box-Ljung (BL) test. The results show that the residuals of the ARMA models follow a white noise process.

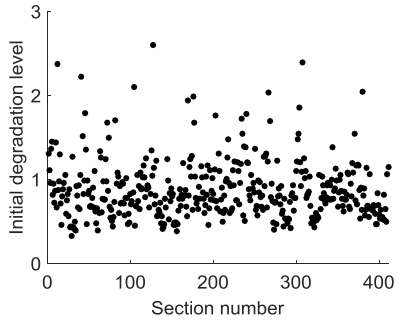

Figure 4. Section to section variation of initial degradation level

About the isolated defects, is observed that a significant number of track sections had at least one type of isolated defects in the period of study (2007 to 2016). The results of the analysis show that the maintenance effect on isolated defects is not durable. In fact, after correction an isolated defect, after a period of 1-2 years a same defect is occurred again in the same location. In addition, it is observed that for a number of track sections a change in degradation parameters is occurred. It is found that this change points are correlated with changes in indicators of isolated defects. The further study is required to find the probability of occurrence of an isolated defect in a track section in an inspection interval. In addition, identifying the root causes of the isolated defects is a challenging topic for further study

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PhD Degrees Completed

Advanced Model-based and Data-driven methods for Prognostics and Health Management of Industrial Systems

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Supervisors:
Prof.Piero Baraldi
and Prof. Enrico Zio
Co-supervisor:
Dr. Francesco Di Maio
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Prognostics and Health Management (PHM) is a field of research and application aiming at detecting the degradation onset of industrial equipment, diagnosing its malfunctioning and predicting its failure time in order to increase the whole system reliability and safety and reduce its maintenance costs. PHM relies on diverse sources of information such as physics knowledge of the degradation process, statistical data on failure times of similar components and data collected through sensors placed on the monitored component which measure signals related to the component behavior and its working and environmental conditions. The available information is used for evaluating the equipment degradation state and predicting its Remaining Useful Life (RUL),

thus enhancing the decision making process which is expected to result in the definition of the optimal time instant in which the maintenance intervention has to be performed. Typically, different industrial applications are characterized by the availability of different sources of information, thus needing to be tackled with suited PHM approaches. Furthermore, modern industrial systems work under variable operating conditions, which are expected to affect the component degradation process and to modify the variation ranges of the monitored signals, thus masking the degradation trends and complicating the development of accurate PHM methods. According to this, the main challenge addressed by this Ph.D. thesis regards the development of PHM methods for industrial systems under variable operating conditions, taking into account the specific setting of practical challenges and available information, which are categorized in terms of knowledge of the system physical behavior, availability of the estimate of the future operating conditions profile and amount of available historical run-to-failure degradation trajectories of similar components.

Three general cases of information available for the PHM model development in practical industrial contexts are considered in this Ph.D. research: *i)* large knowledge of the system behavior in the form of a physics-based model of the degradation process, availability of estimates of the future operating conditions profile and of their effects on the degradation process, and few available data from historical run-to-failure component degradation trajectories; *ii)* low knowledge of the system behavior, estimation of the future operating conditions profile not available and few available run-to-failure trajectories; *iii*) low knowledge of the system behavior, available estimate of the future operating conditions profile and of their effects on the degradation process, and large amount of data from run-to-failure trajectories.

With respect to case *i)*, we resort to a model-based prognostic approach for components working under variable operating conditions. The available physics-based degradation model of the component is embedded into a Particle Filter (PF) framework for the estimate of the component degradation state and into a Monte Carlo approach for the prediction of its RUL and the quantification of the associated uncertainty. In this case, the novelty introduced in this Ph.D. thesis is the definition of a novel component degradation indicator which is independent from the operating conditions. The performance of the developed approach is evaluated with respect to an experimental case study regarding the RUL prediction of electrolytic capacitors working under variable operating conditions in Fully Electric Vehicles (FEVs), which are responsible for almost 30% of the total number of failures in motor powertrain.

With respect to case *ii)*, we develop a data-driven degradation classifier for components working under variable operating conditions. The developed classification model is based on the use of an ensemble of Self-Organizing Maps (SOMs), which allows handling typical industrial signals characterized by large noise and by the presence of outliers.

In this case, the novelty introduced in this Ph.D. thesis is the creation of an ensemble formed by component-based degradation classifiers, which are based on SOMs trained using only healthy data collected from the component under test and are therefore specially tailored on it and on its operational and environmental conditions, and population-based degradation classifiers, which are based on SOMs trained using healthy data collected from components similar to that under test and are therefore representative of the healthy behavior of a general component. The performance of the developed approach is evaluated with respect to an experimental case study regarding the assessment of the health state of Insulated Gate Bipolar Transistors (IGBTs) working in FEVs under variable operating conditions, which are among the most critical and extensively exploited components in electrical systems.

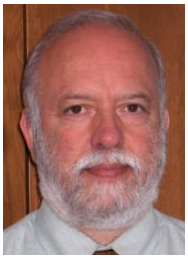
With respect to case *iii)*, in this Ph.D. thesis we develop a data-driven Artificial Intelligence (AI)-based prognostic approach for components working under variable operating conditions. The proposed approach resorts to Echo State Networks (ESNs), a relatively new approach for training Recurrent Neural Networks (RNNs). Thanks to the RNN intrinsic memory properties provided by the internal cyclic connections among neurons, ESNs allow taking into account the whole specific degradation history of the monitored component, thus providing more accurate predictions of the component RUL. In this case, the novelty introduced in this Ph.D. research is the creation of a local ensemble of ESN models, optimized by using a Multi-Objective Differential Evolution (MO-DE) algorithm for enhancing the individual models diversity, which aims at predicting the component RUL and the associated uncertainty by exploiting the individual models memory properties for the aggregation of their outcomes. The performance of the developed approach is evaluated with respect to an experimental case study regarding the RUL prediction and uncertainty quantification of a fleet of turbofan engines working under variable operating conditions, which are among the most critical aircraft components from both the safety and the availability points of view.

According to the obtained results, the PHM approaches developed in this Ph.D. thesis are shown able to improve the accuracy and the confidence of the degradation assessments and RUL predictions with respect to conventional PHM approaches. The outcomes of this Ph.D. are expected to reduce the gap between the PHM methodological research and the practical implementation of PHM techniques in industrial applications, providing a framework for the selection of the strategy to adopt for tackling specific cases characterized by different available information.

The methods developed during this Ph.D. thesis are now carried on, improved and applied to real industrial situation within my engineering consulting activity at ARAMIS (www.aramis3d.com), where I am the

leading developer of machine learning and artificial intelligence techniques for predictive maintenance solutions and applications.

RESS News



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

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.

Volume 166 has published the special issue Reliability and Performance of Multi-State Systems, guest edited by Gregory Levitin and Liudong Xing

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
- Maintenance Modelling
  Guest Editors: Shaomin Wu, Phuc Do

Presently the following special issues are **open to submissions**:

- 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: "Advanced methods for reliability, availability, maintainability, diagnostics and prognostics of industrial equipment"

Author: Francesco Di Maio

The 2016 professional one-week training course: "Advanced methods for reliability, availability, maintainability, diagnostics and prognostics of industrial equipment" took place at Politecnico di Milano, Milan (Italy) on November 21-24.

The course was the XIX edition of the series. Its goal has been to provide the participants with the methodological competences and the computational tools necessary to tackle critical problems in the areas of reliability, availability, maintainability, diagnostics and prognostics. To this purpose, the course has presented proven methods to improve safety, increase efficiency, manage equipment aging and obsolescence, automate maintenance and reduce maintenance costs of industrial systems.

Since the beginning, the course has been officially supported by ESRA and since 2005 official scholarships have been offered. The 2016 edition of the course has been supported by ESRA with two scholarships covering the registration fee. The 2016 scholarships have been offered to two Ph.D students, one of Univeristy of La Sapienza (Roma, Italy) and the other of Politecnico di Milano (Milano, Italy).

The first part of the course has been 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 (Auto Associative Kernel Regression, Wavelet transforms, Artificial Neural Networks, Echo State Networks, Particle filter) is illustrated. In the second part of the course, exercise sessions on Monte Carlo simulation, Artificial Neural Networks and Auto Associative Kernel Regression 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 have been presented by the course organizers and participants. The applications range from Monte Carlo Simulation for availability analysis and condition-based maintenance management to regression and classification techniques for fault detection, classification and prognosis in different industrial sectors.

The 2017 edition of the course fill take place at Politecnico di Milano, Milan (Italy) on November 2017.

XVIII Dependability Conference (XVIII Congreso de Confiabilidad)

Organized by the Spanish Dependability Society (Asociación Española para la Calidad, AEC). Held 23 and 24 November in Madrid (Spain). The participants came from the industrial sector and from Universities and in the meeting the main discussion was about the challenge of applying the concept **Industry 4.0**, and the importance of dependability in this context. The application of this concept relays on the use of techniques such as big data, cloud monitoring and statistical analysis to improve industry competitiveness. In this way several tools to cope with this objective were presented.

Invited Lecture on "Advances in product qualification and supply chain responsibilities"

Author: Francesco Di Maio

On November 25, at Politecnico di Milano, an invited lecture has been held by Prof. Michael Pecht (Director and Chair Professor, Center for Advanced Life Cycle Engineering, University of Maryland, College Park, Maryland, USA) on the topic "Advances in product qualification and supply chain responsibilities". The successful event has gathered more than 50 international researchers and professionals (engineers, maintenance professionals, facility managers and operators) as well as university students with an interest in Reliability, Availability and Maintainability (RAM) in various applications (transportation by air, land and sea, manufacturing, power production, …). The event was organized by Politecnico di Milano and supported by ARAMIS S.r.l, the Prognostics and System Health Management technical committee of ESRA, the Nuclear Industry technical committee of ESRA and the IEEE Reliability Society, Italy Chapter. The talk addressed the nowadays rapid products change, customer's numerous choices and tremendous price pressure on suppliers that are pressured to test quickly their products.However, the traditional test and qualification standards were claimed not to be working. Over the past 10 years, there have been an increasingly large number of products that have passed qualification tests but have failed in the field. The resulting costs of these failures have been in the hundreds of millions of dollars for many companies. This lecture has overviewed why the current methods are inadequate, why the standards need to be replaced and how companies can qualify products in an accelerated manner to ensure acceptable reliability. Virtual qualification, accelerated testing, target application requirements, failure mechanisms and models, and prognostics-based qualification were discussed, with various examples. Responsibilities with the supply chain were also presented.

Past Safety and Reliability Events

Seminar on "Uncertainty analysis in engineering calculations" Politecnico di Milano

April 10, 2017

Author: Francesco Di Maio

On 10 April 2017, at Politecnico di Milano a seminar was held on the topic of "Uncertainty analysis in engineering calculations". The event (organized by NAFEMS, IEEE Reliability Society, the European Safety and Reliability Association (ESRA), Center for Reliability and Safety of Critical Infrastructures (CRESCI, China), CentraleSupelec (France) Politecnico di Milano (Italy), and ARAMIS Srl) has dealt with recent advances in engineering modeling and simulation that are expected to allow representing and predicting the behavior of (more and more) complex systems.

Simulation resorts to computational models to support a product entire lifetime analysis, from its design phase to implementation. However, although models can be precise and accurate, they are not able to fully catch reality; In fact, while the models have a deterministic nature, always producing identical results at each execution, reality manifests stochasticity. For example, nominally identical components fail in different times and modes; Loads on structures and systems due to, for example, earthquakes, waves or winds stochastically vary over time; In addition, the actual model parameter values are not known precisely. Traditional approaches to computational analysis consist in the use of purely deterministic models, and all random effects are taken into account through the use of safety factors. However, the use of safety factors can lead to excessively oversized and uneconomic systems, or to sub-optimal and expensive design. By means of a systematic and comprehensive treatment of uncertainties, however, it is possible to obtain optimal design of products, to guarantee reliability and product robustness.

The seminar provided:

• An overview of the latest developments in the field of reliability analysis, robust modeling of uncertainties, advanced Monte Carlo simulation

• Examples of how uncertain simulation is used in industrial applications to improve complex product design

The detailed program was as follows

9:00 - 9:15 Introduction and welcome message (Matteo Broggi, Leibniz Universität Hannover; Francesco Di Maio; Politecnico di Milano; Enrico Zio, Politecnico di Milano)

9:15-9:45 Prediction of residual life of industrial components for the purpose of defining predictive maintenance strategies (Piero Baraldi, Politecnico di Milano)

9:45-10:15 Quantification and propagation of uncertainties in Structural Analysis (Matteo Broggi, Leibniz Universität Hannover)

10:30 - 11:00 Integrate the identification of key-uncertainty drivers in quantifying uncertainty (Emanuele Borgonovo, Bocconi University)

11:00 -11: 30 Reliability Analysis for Safety-Critical Applications (Silvia Poles, Noesis Solutions NV)

11:30-12:00 Applying robust decision-making methods to choose security barriers and protections in industrial plants (Michele Compare, ARAMIS S.r.l.)

12:20-12:50 Reliability-based Robust design optimization applied to Aeronautics (Francesco Franchini, EnginSoft S.p.A.)

12:50-13:20 Optimization of Composite Layers Layout of an Aeronautical Component using an ISight-based Intelligent Decision Advisor, iDA (Luca Fattore, EXEMPLAR S.r.l)

The success of the event has stimulated planning of numerous other seminars, which will be held in the coming months at Politecnico di Milano, in close collaboration between NAFEMS Italia, IEEE Reliability Society and ESRA.

Seminar series on system reliability, risk and resilience

Politecnico di Milano, Italy
26th June 2017

On 26th June 2017, at Politecnico di Milano the summer edition of the Seminar series on system reliability, risk and resilience was held. The event (supported by IEEE Reliability Society, the European Safety and Reliability Association (ESRA), Center for Reliability and Safety of Critical Infrastructures (CRESCI, China), CentraleSupelec (France) Politecnico di Milano (Italy), and ARAMIS Srl) has presented the advancements in risk assessment in light of the emerging digitalization of control systems. This, on one hand, brings opportunities but, on the other hand, with it comes also the complexity of cyber-physical systems (CPSs): climate change and extreme natural events are increasingly threatening infrastructures and CPSs, terrorist and malevolent threats are posing severe concerns for the security of our systems and lives, to only mention few. These sources of hazard are extremely uncertain and, thus, difficult to describe and model quantitatively.
To cope with the situation depicted above, risk assessment must evolve for addressing the existing and future challenges, and considering the new systems and innovations that have already arrived in our lives and that are coming ahead.
Considering the ever increasing computational capabilities and data availability, some research and development directions that are emerging are presented and discussed, including the use of simulation for accident scenario identification and exploration, the extension of risk assessment into the framework of resilience and business continuity, the reliance on data for dynamic and condition monitoring-based risk assessment.
The speakers that have contributed are hereafter listed

- Prof. Enrico Zio, Politecnico di Milano, Energy Department and Director of the Chair on Systems Science and Energetic Challenge, CentraleSupelec, Fondation EDF (Electricite' de France)
"The future of risk assessment"

- Prof. Lixuan Lu, Faculty of Energy Systems and Nuclear Science, University of Ontario Institute of Technology
"Analysis of fault tolerant design methods for single event effects in field programmable gate array-based systems using the dynamic flowgraph methodology"

- Dr. Francesco Di Maio, Politecnico di Milano, Energy Department
"Integrated Safety and Securiy Analysis for Cyber-Physical Systems"

The success of the seminar has encouraged planning a "Fall Edition" of the Seminar series on system reliability, risk and resilience, to be held in October 2017 in Politecnico di Milano (Italy).

Calendar of Safety and Reliability Events

36th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2017)
Symposium on Structures, Safety and Reliability

Trondheim, Norway
25-30 June 2017

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.

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

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

Conference Website: **http://www.omae2017.com**

The International Conference on Information and Digital Technologies 2017 (IDT 2017)

Zilina, Slovakia
5-7 July 2017

The International Conference IDT'2017 is the annual event. The aim of the Conference is to bring together researches, developers, teachers from academy as well as industry working in all areas of digital technologies. Especially young researchers and postgraduate PhD students are greatly welcome to

participate in this event. Beside the scientific field, several cultural and social events are planned for the enjoyment of the Conference attendees.

Each paper will be evaluated for acceptance by at least two peer reviewers. Furthermore, paid registration to the Conference is mandatory for paper acceptance (one registration per paper). We are going to add the publication of the full set of accepted papers IEEEXplore, Scopus and Web of Science.

Special events:

The two Workshops in framework of the conference will be organized:

- Int. Workshop on Biomedical Technologies
- Int. Workshop on Reliability Technologies

Important dates:

- March 13, 2017 – Full paper submission
- May 22, 2017 – Paper acceptance notification
- June 5, 2017 - Camera-ready papers
- June 19, 2017 - Final program

Conference website:
http://idt.fri.uniza.sk ; **http://idt.fri.uniza.sk/idt2017**

15th International Probabilistic Workshop (IPW)

Dresden, Germany
27-29 September 2017

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.

The 10th Dresdner Probabilistik Workshop will be hold in connection with the 15th International Probabilistic Workshop.

Key topics:
Safety, Risk, Probabilistic Computation, Reliability, Structural Safety, Mechanical Safety

Organisers:
Dr.-Ing. Matthias Voigt,
Prof. Dr.-Ing. Wolfgang Graf,
Prof. Dr.-Ing. habil. Ulrich Häußler-Combe,
Prof. Dr.-Ing. M. Beer,
Dr.-Ing. habil. Dirk Proske
Technische Universität Dresden,
Faculty of Mechanical Engineering & Faculty of Civil Engineering

Important dates:

- March 15, 2017 - Submission Abstract
- June 30, 2017 - Submission Final Paper

Event information and contacts:
Event website: **http://ipw15.probabilistic.info**

Dr.-Ing. Matthias Voigt
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20th edition of the Course on "RAM&PHM 4.0: Advanced methods for Reliability, Availability, Maintainability, Prognostics and Health Management of industrial equipment"

Politecnico di Milano, Milan, Italy
9-12 October 2017

Author: Francesco Di Maio

Mission and Goals:

In recent years, the volume of data and information available in the industry has been growing exponentially and more sophisticated and performing analytics have been developed to exploit them. This exciting situation offers great opportunities of optimized, safe and reliable productions and products, including optimal predictive maintenance for "zero-defect" production, with reduced warehouse costs and improved system availability with "zero unexpected shutdowns". To grasp some opportunities, new system analysis capabilities and data analytics skills are needed.

The goal of the 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 industrial equipment. The course presents advanced analytics to improve safety, increase efficiency, manage equipment aging and obsolescence, set up condition-based and predictive maintenance.

Participants:

The course is mainly dedicated to control, process, quality and maintenance engineers, data scientists, data miners, researchers
and PhD students in the area of Reliability, Availability,Maintainability (RAM) and fault diagnostics and Prognostics and Health Management (PHM).

Training Format

Lectures will be held in English. All participants will receive a
complete set of the presentation slides with specific examples
and case studies, selected reference lists and resources in electronic format, and a participant certificate.

Submission Dates:
Return the registration form before September 22, 2017 to coursesdeng@polimi.it.

Scholarships
The European Safety and Reliability Association (ESRA, www.esrahomepage.org) supports the course with two scholarships to be awarded to PhD students. Scholarships will be assigned considering the affinity of the research to the topics of the course, the quality of the CV and the number and impact of publications in the field.

Course program chair:
Dr. Francesco Di Maio
tel: (+39)02 2399 6372
francesco.dimaio@polimi.it

Administrative secretariat:
Ester Dall'Aglio
e-mail: courses-deng@polimi.it

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
- TECNUN, 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
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- INERIS, France
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- Technische Universität Wuppertal, Germany
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- Institute of Nuclear Technology Radiation Protection, Greece
- University of the Aegean, Greece
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- Universita Degli Studi di Pavia, Italy
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- Institute for Energy Technology, Norway
- Norwegian Univ. Science & Technology, Norway
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- Technical University of Gdansk, Poland
- Gdynia Maritime Academy, Poland
- Institute of Fundamental Techn. Research, Poland
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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

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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

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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 http://www.esrahomepage.eu
For application for membership of ESRA, please contact the general secretary Coen van Gulijk E-mail: c.vangulijk@hud.ac.uk.
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