European Safety and Reliability Association

Newsletter

http://www.esrahomepage.org

December 2012

Editorial

Enrico Zio
ESRA Chairman
Politecnico di Milano, Italy
École Centrale Paris,
Supelec, France

Dear ESRA member,

We come to the last issue of our newsletter for 2012 and this is a good opportunity for me to thank you for the efforts that once again you have made this year to support, contribute and participate to the initiatives and activities of ESRA, starting from the joint conference ESREL 2012/PSAM 11 in Helsinki, continuing with your involvement in our Technical Committees and ending with the many proposals of initiatives received for support by our Association.

This leaves me very optimistic for next year's activities of ESRA and I look forward to joining you in them to enjoy your professional expertise and personal friendship.

Best wishes for the coming year.

Enrico Zio
Chairman of ESRA

Feature Articles

Integrated failure rate estimation in the process industry with non-parametric BBN's

Coen van Gulijk, Daniea Hanea, Pei-Hui Lin, Simone Sillem, Ben Ale.
Safety Science group, Delft University of Technology, Delft

Introduction

According to Gupta (2002) fewer accidents happen in the chemical process industry than would have happened if the Bhopal catastrophe had not changed managers' and governments' attitudes towards safety in the chemical process industry. Despite that the occurrence of major accidents persists (Nivolianitou *et al.*2006). And yet again we were surprised by the Deepwater Horizon disaster, its extensive environmental consequences and its staggering cost. The staggering cost, the loss of industry good-will, and international attention to safety have changed the attitude to safety gain and prompted Shell tojoin forces with the safety science group to refine its safety models.

Research approach

Today, QRA methods based on the purple book (1999) work with fixed failure rates for equipment. In this work, the estimates are refined with organizational and human factors. This refinement yields to improved identification of safety critical equipment and processes and leading indicators for safety.

The required refinement of failure rate estimates is based on non-parametric BBN's that were developed earlier in the CATS project (Ale, 2009). Important advantages are that the connection between nodes is less restricted than in fault tree methods and that uncertainties are an intrinsically part of the method.Similar to the CATS method, the BBN structure is built up in three layers: the technical layer, the management layer and the human factors layer. The technical layer is subdivided into three aggregate levels that are familiar from QRA methods in the purple book: factories, units and components. In this project, the building blocks are designed to be generic so that a single BBN structure can be used over and over again in the calculation structure. The building blocks are similar to the ones in the purple book (e.g.: pipes, vessels and pumps).

Example: generic safeguard BBN

The occurrence of the events for the activation of a safeguard can be best described in an event sequence diagram. Figure 1shows the translation into a generic BBN,which can be used over and over again for any safeguard in the process. Without prior knowledge, it is assumed that the distributions are normal with mean equal to point value Px and standard deviation 0.1x Px. If detailed information is available, the distributions can be changed accordingly. In addition, managerial and human factors models can easily be linked into the nodes of this generic BB

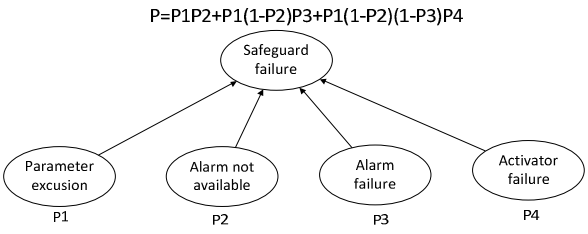

Figure 1: BBN for generic safeguard.

Outlook

Currently, generic BBN's are developed for units and components of chemical plants. Also, research is proceeding on the development of management factors and human factors. These methods will be integrated lateron in 2012 to yield proof-of-concept model. Those developments will be reported in the open literature.

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Probabilistic Risk Assessment: Mathematical and Algorithmic Challenges

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Introduction

Fault Tree Analysis is the most widely used technology for Probabilistic Risk Assessment. It is both simple and robust. A few hours are sufficient for anyone with a standard background in mathematics, physics or computer science to learn how to build a Fault Tree, the notions of cutset and cutoff, the main probability distributions associated with Basic Events and the various reliability indicators of interest. Thanks to their graphical nature, Fault Trees are easy to design with modern computer interfaces (drag and drop, multi-views, hyperlinks…). Good computer tools actually exist to support the methodology (e.g. Risk Spectrum, CAFTA…). For all these reasons, Fault Tree Analysis is used to perform risk assessment of most of critical systems, possibly in association with complementary but equivalent formalisms such as Block Diagrams or Event Trees. Fault Tree Analysis is recommended by standards and regulations.

In this note, I would like to point out some of the issues with the methodology, with a double aim: first to warn Safety Analysts about these issues, so they can better master the methodology; second to propose some research directions for scientists and tool

designers in order to improve the current state of affairs.

Design and Maintenance of Models

Fault Trees are just (probabilized) Boolean formulas. This is not much to deal with the complexity of nowadays industrial systems. This lack of expressiveness induces a distance between models and systems under study. The gap is filled with the experience – one would say the art – of the Safety Analyst. As a consequence, any safety model embeds a great deal of implicit knowledge. Models are thus hard to share amongst stakeholders and to maintain throughout the life-cycle of the systems. Their maintenance is especially tedious and error-prone. Each time specifications of the system change, they should be inspected to seek for impacts. Guidelines for Fault Tree construction can be helpful but cannot solve all of the problems. There is here a big room for methodological and technological improvements, in at least three directions.

First, traceability of design decisions needs to be improved. Today, such traceability is at best documented by means of notes that are external to both system specifications and safety models. The irreversible trend towards Model Based System Engineering will probably improve the situation. But supporting tools remain to be designed. Model documentation is also an issue. New ideas are mandatory to make significant progresses.

Second, model management needs to be improved. In Fault Tree (and Event Tree) Analysis, variants and configurations are usually encoded by means of House Events. The model level and meta-model level are thus mixed-up. As a consequence, models are larger lthan they should be, eventually less readable and embedding implicit knowledge. In the same vein, none of the tools available on the market provides a way to define and to compare (graphically) two variants of a model. This feature would however a very useful to visualize changes. A major trend in all industries consists in managing engineering data into collaborative data bases (Product Data Management, Product Life-Cycle Management…). In midterm, they will be used to manage risk analyses as well. Such data bases provide the infrastructure. They do not provide a way to version and to configure models. Moreover considering models only is much too restrictive because calculations performed on the models must be managed too. We can import into the Reliability Engineering fields some of the concepts and tools developed for Software management. But this probably won't be sufficient. Here again, new ideas are necessary to make significant progresses.

Third, Fault Trees (Event Trees, Block Diagrams) could be better generated from higher level models, closer to the functional specifications. This approach aims to reduce the distance between systems and models. More than ten years of experience with the AltaRica language show that it presents many advantages, including being cost effective. I'm deeply convinced that Model Based Safety Analyses is (at least part of) the future of Safety and Reliability Engineering. But I'm also deeply convinced that this approach requires the development of Domain Specific Languages such as AltaRica. Attempts to use either architectural formalisms such as SysML or multi-physics simulation languages such as Matlab-Simulink will fail because these formalisms do not (and cannot) embed the mathematical concepts mandatory to perform Probabilistic Risk Analyses. This topic deserves a thorough treatment which goes beyond the objective of this note. The development of Model Based Safety Analyses is clearly one of the main scientific and technological challenges for the next future.

Assessment of Models

Safety models are not designed for the only purpose of documentation or communication. They are designed to perform virtual experiments, i.e. to calculate reliability indicators (top event probabilities, importance factors…) and to extract failure scenarios (minimal cutsets). It turns out that these calculations are very resource consuming. Technically, the calculation of the top event probability of a Fault Tree is #P-hard. Even approximations are hard. For readers not familiar with complexity theory, it means that it is mathematically proven that no efficient algorithm exists to approximate accurately the top event probability and a fortiori to calculate its exact value. This (negative) result shapes the whole field. As a consequence, the design of a model results always of a tradeoff between the accuracy of the description and the ability to perform computations with reasonable computing resources.

Because of repeated events, assessing the Top Event probability is not possible straight from the Fault Tree. An intermediate formula – a normal form – has to be computed first. The probabilistic calculations are then performed from this intermediate formula. So far, two normal forms have been proposed in the literature: Minimal Cutsets and Sums of Disjoints Products.

For any formula (including a non-coherent one), there exists an equivalent Sum of Disjoint Products. Up to now, Binary Decision Diagrams are the most efficient technology proposed to calculate Sum of Disjoints Products. The exact Top Event probability can be computed in linear time from a Sum of Disjoint Products. This property comes with a price. The calculation of Sum of Disjoint Products suffers from the exponential blow-up, even using Binary Decision Diagrams.

Minimal Cutsets can be computed by top-down algorithms, such as MOCUS (as implemented for instance in Risk Spectrum), or by bottom-up algorithms, typically using Zero-Suppressed Binary Decision Diagrams (as implemented in FTREX, the calculation engine of CAFTA). Minimal Cutsets are

interesting from a qualitative point of view for they represent minimal scenarios of accident/failure. By applying cutoffs, one can select only the most probable Minimal Cutsets therefore keeping the computation resources reasonable. If probabilities of Basic Events are low and the model is (almost) coherent one gets usually accurate results in this way. Modern algorithms can keep track of discarded candidate Cutsets so that the approximation is controlled (on coherent models only).

The experience from these last ten years shows that models with up to several hundreds of variables can be handled by means of Binary Decision Diagrams. When such an approach is feasible, it should be applied for it provides exact results and it usually outperforms the Minimal Cutsets approach. Despite of all efforts and interesting partial results, the Sum-of-Disjoint products approach seems however unable to deal with large Event Tree/Fault Tree models coming from the nuclear industry. These models embed typically several thousands of Basic Events and about the same number of gates. My feeling is that we hit here a hard complexity barrier. On these models, Minimal Cutsets algorithms are able to generate several hundred thousand Minimal Cutsets within minutes on personal computers. This performance is obtained by using massively cutoffs.

The use of cutoffs raises a number of issues that are not always well understood. First, only a small proportion of Basic Events shows up in the calculated Minimal Cutsets. Several experiments I made with American, European and Japanese models show that it is very often the case that less than ten percent of Basic Events show up in the calculated Minimal Cutsets. In other words, ninety percent of the model is just ignored for probabilistic calculations. This makes the calculation of importance factors dubious. As pointed out by Nicolas Duflot in his PhD thesis, the ranking of Basic Events tends to change in a chaotic way depending of the chosen cutoff. The same remark applies to sensitivity analyses: Monte-Carlo simulations do not give the same results depending whether Minimal Cutsets are recalculated for each set of Basic Event probabilities or not. Second, analyses are not stable by refinement. If, for some reasons, the analyst decides to develop further some of the Basic Events, the refined Minimal Cutsets may drop under the cutoff. To put it to the extreme, by refining sufficiently the model, he may reach the conclusion that there is no risk at all! This phenomenon may change dramatically the ranking of components with respect to their contributions to the overall risk.

The above discussion has in my opinion at least two important consequences. First, we need to better understand what is actually calculated. By extracting Minimal Cutsets with a cutoff, we filter the model under study. We reduce it to a possibly much simpler model. This simpler model is equivalent to the original one with respect to the observation means at hand (i.e. the calculation of Minimal Cutsets). Software tools should provide functionalities to visualize this reduced model. Second, at a methodological level, these notions of abstraction/reduction/refinement/filtering should be explored. Standards and best practices guides must incorporate discussions about these issues.

Conclusion

In this short note, I tried to point out some issues about Fault Tree Analysis. It is definitely a computer scientist view of the question, with emphasis on mathematical and algorithmic aspects. I hope to have convinced the reader that there remain many research topics in this area. Methods and tools have to be improved. With that respect, I'm a strong believer in openness: peer review of models, standardized exchange formats to be able to cross check results with different tools, openness of tools themselves...

Probabilistic Risk Assessment at large is a great technology, with applications far beyond safety *stricto sensu*. Our community is in charge of developing it.

Spatial variability in the piping failure mechanism of dikes

Wim Kanning
Delft University of Technology: TU Delft

Piping is an important failure mechanism of flood defense structures. My thesis focuses on earthen levees that are subject to the piping mechanism. A levee fails due to piping when a head difference causes first the uplift of an inland blanket layer and subsequently erosion due to a ground water flow. If this ground water flow is strong enough, soil particles are washed from below the levee until it is undermined and collapses. The piping mechanism is surrounded by high uncertainties, especially in the geotechnical properties and the subsoil composition. Reliability analysis is applied to calculate the probability of failure with respect to piping and the contribution of the different uncertainties. Due to rapid fluctuation of soil uncertainties in space, the probability of piping failure increases with the length of the structure, the so-called length-effect. This can be compared with a chain, the longer the chain, the higher the probability of a weak link. Because of found high piping failure probabilities and increasing awareness about the potential danger of the failure mechanism, this thesis deals with the length-effect in the piping mechanism. The thesis is divided in three parts.

Part A deals with general flood risk. First, the contribution of piping to levee failures is analyzed, based on historical floods. Mainly the 2005 New Orleans flood disaster in general and the London Avenue South breach specifically are discussed. Additionally, supposed piping failures around the world, but mainly the Netherlands and the US are analyzed. Second, general reliability analysis and length-effect modeling techniques are discussed and applied to case studies in the Netherlands.

Part B deals with uncertainty propagation in the piping mechanism. Initially all uncertainties affecting the piping mechanism are assessed, using the (advanced) Sellmeijer model, and known length-effect theories are applied. It is shown that permeability and grain size are the highest contributors the probability of piping failure next to adverse geological details. Subsequently, two approaches are used to potentially improve the modeling of uncertainty propagation in the piping model. First, the combination of a random field model and a weakest link model is used to find the effective distributions of grain size and permeability. On the one hand the mechanism finds the weakest link but on the other hand the total resistance is determined by the strongest link within the weakest path. The second approach is to use a simpler critical average gradient model (e.g. Bligh's model) with one model factor covering all uncertainty. The distribution of the model factor is determined based on historical failures using Bayesian inference. It is found that inferred model uncertainty on the gradient model is higher than the total propagated uncertainty in the Sellmeijer model.

Part C deals with risk based decision making. Risk based design and decision tools are discussed and applied to the piping mechanism. In case of unacceptable high failure probabilities, several options are available, of which structural improvement and doing local measurements are the most important. Measurements do not necessarily reduce the failure probability but give a better overview of which levees should be improved. Especially the exclusion of adverse geological details and permeability measurements can be cost-effective measures. Finally, the implication of the length-effect on structural measures is discussed.

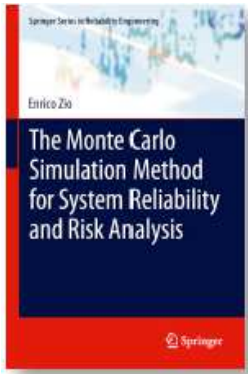
The main conclusions from this thesis are that the piping mechanism is a very significant threat to flood defenses; that the length-effect causes the failure probability of levee systems to increase with its length and that performing local measurement in combination with local levee improvements are a cost-effective method to deal with unacceptable piping failure probabilities

Safety and Reliability Books

The Monte Carlo Simulation Method for System Reliability and Risk Analysis

Enrico Zio
École Centrale Paris, Chatenay-Malabry, France

Monte Carlo simulation is one of the best tools for performing realistic analysis of complex systems as it allows most of the limiting assumptions on system behavior to be relaxed. The Monte Carlo Simulation Method for System Reliability and Risk Analysis comprehensively illustrates the Monte Carlo simulation method and its application to reliability and system engineering. Readers are given a sound understanding of the fundamentals of Monte Carlo sampling and simulation and its application for realistic system modeling.



Whilst many of the topics rely on a high-level understanding of calculus, probability and statistics, simple academic examples will be provided in support to the explanation of the theoretical foundations to facilitate comprehension of the subject matter. Case studies will be introduced to provide the practical value of the most advanced techniques.

This detailed approach makes The Monte Carlo Simulation Method for System Reliability and Risk Analysis a key reference for senior undergraduate and graduate students as well as researchers and practitioners. It provides a powerful tool for all those involved in system analysis for reliability, maintenance and risk evaluations.

Website:

springer.com/ebooks

springer.com/mycopy

Past Safety and Reliability Events

Looking Back at PSAM11-ESREL 2012

Helsinki, Finland, 25-29 June 2012

Reino Virolainen
General Chair
Radiation and Nuclear Safety Authority (STUK)

Terje Aven
Technical Program Chair
University of Stavanger

The International Association for Probabilistic Safety Assessment and Management (IAPSAM) and the European Safety and Reliability Association (ESRA) organized jointly the PSAM11 and ESREL 2012 Conference on safety, reliability and risk assessment, 25-29 June 2012, in Helsinki, Finland. Much of the practical work was carried out by the local organizers STUK (Radiation and Nuclear Safety Authority), VTT (Technical Research Centre of Finland), Aalto University and the Finnish Nuclear licensees, Fortum and TVO and the conference secretariat, Congrex, Blue and White Oy.

The conference brought together a large number of experts from various industries, research organizations, regulatory authorities and universities. The number of attendees was no less than 850 from 43 countries. The country distribution is shown in the figure below. Finland and France were represented by a bit more than one hundred participants, United States by 88, Germany by 86 and Norway by 66 participants, to mention countries exceeding 50 registered participants.

The technical program included 759 papers in 30 technical tracks covering all of the major areas of reliability and risk assessment methods and applications including nuclear, process and chemical industries, offshore and marine, space and aviation, civil engineering and financial management, IT and telecommunications, bio and medical technology, just to name a few. The number of student papers was 130 altogether.

Besides the typical PSAM and ESREL topics, the program included several special sessions which addressed novel, unresolved and burning issues like Imprecise Probabilities, Passive Safety Systems and , the Fukushima Accident - 25 altogether.

In addition to the nominal sessions the program included also two panel discussions - Fukushima accident panel and human reliability panel. Both panels were popular with many participants, and a high number of papers were presented linked to these topics.

Each conference day was opened with a plenary session. The plenary talks by Enrico Zio, Jukka Laaksonen, Ashok Thadani, Jan Erik Vinnem, Pierre-Etienne Labeau, Luca Podofillini, Antoine Rauzy and Ali Mosleh, covered some key topics related to uncertainty treatment in risk assessment, safety goals, management of nuclear and offshore risks, various aspects of RAM (reliability, availability, maintenance) analyses, and the future of probabilistic risk assessment. The files of these presentations are found on the website www.psam11.org.

A highlight of the conference was the event in which four young scientists in the field of reliability and risk assessment were awarded the George Apostolakis Fellowship for their high quality work. The Honorary chairman, Commissioner USNRC, George Apostolakis introduced the award-winning young scientists and handed the memory plaques over to the awardees, Dr. Reese Clothier, Dr. Katrina Groth, Dr. Brian Johnson and Dr. Zahra Mohaghegh.

Besides the technical program, the conference offered also an extensive exhibition area where sponsors and industries presented their commercial products and services.

We conclude that the conference served well the aim of promoting and extending the use of reliability, safety and risk assessment methods in new areas of technology and providing incentives for further theoretical and practical developments.

It was an honour and a great pleasure to have the opportunity to co-operate with you all during the PSAM11-ESREL 2012 conference, both at the planning stage and during the Conference in June.

Summer Safety and Reliability Seminar (SSARS 2012)

Sopot, Poland, 2-8 Sept. 2012

Krzysztof Kołowrocki & Joanna Soszńska-Budny, Gdynia Maritime University, Gdansk, Poland

The SSARS Seminars are organized each year by Polish Safety and Reliability Association – PSRA and European Safety and Reliability Association – ESRA in a resort Sopot placed at the Baltic seaside in Poland. The 6-th Seminar took place on 02-

08.09.2012. and as usual was chaired by prof. Krzysztof Kołowrocki, dr. Joanna Soszyńska-Budny from Gdynia Maritime University and prof. Enrico Zio from Polytechnic of Milan.

The idea beyond the organization of the annual, one-week *Summer Safety and Reliability Seminars* is to provide a forum for discussing, advancing and developing methods for the safety and reliability analysis of the complex systems, which form the backbone of our modern Societies. The subjects of the Seminars are chosen each year by the Programme Board in an effort to dynamically represent the methodological advancements developed to meet the newly arising challenges in the field of safety and reliability analysis.

This year the emphasis was addressed to the following subjects:

• Reliability and Safety of Complex Systems and Networks;

• Risk Analysis Methods in Transportation;

• Complex Systems Dependability;

• Risk and Safety Improvement;

• Safety of Critical Infrastructures.

Both 1-2 hours lectures on advanced methods (accompanied by a corresponding full text of up to 12 pages) and technical presentations of 20-30 minutes on applications of such methods (with corresponding full text of up to 8 pages) are offered during the plenary sessions and the seminar sessions, respectively.

The extended version of papers and lectures in the form of articles are collected in the *Journal of Polish Safety and Reliability Association: Summer Safety and Reliability Seminars – JPSRA* (http://jpsra.am.gdynia.pl), which constitute an up-to-date reference textbook for the participants to the Seminars and all the researchers in the field. *JPSRA* is an international journal devoted to the development and application of the methods of modelling, identification, prediction and optimization of the reliability, safety and security of complex systems and processes. The journal mainly publishes the papers and lectures accepted for and presented at the *Summer Safety and Reliability Seminars*. The *JPSRA* Editorial Board with the assistance of the Invited Professors have performed the evaluations of all contributions: as a result, recommendations have been sent out to help the authors improving their work. In all, 34 papers and lectures have been accepted for presentation during the Seminar and 28 out of them were published in the *JPSRA*. 14 of the papers and lectures are included in Number 1 and 14 of the papers and lectures are included in Number 2.

SSARS 2012 was financially supported by the Poland's Ministry of Science and Higher Education and by the ESRA. These supports, we thank a lot, helped us to make SSARS 2012 one of the most excellent safety and reliability event.

More details on SSARS 2012 may be found at http://ssars.am.gdynia.pl

The next SSARS Seminar will be he held in Sopot on 23-29.06.2013 and be mainly focused on the Safety, Security and Reliability of Critical Infrastructures and Nano-Systems which are currently two main subjects in the world safety science activity.

ESRA News

ESRA TC on Human Factors and Human Reliability

Luca Podofillini, ESRA and the HRA Society,

The last day of the 2012 joint PSAM – ESREL conference gave a great opportunity to present in a plenary talk some highlights of the activity of the ESRA Technical Committee (TC) on Human Factors and Human Reliability. The analysis of human performance is crucial to the effective risk management of industrial systems and this ESRA TC promotes topical discussions and experience-sharing for the methodological and practical advancement of the field. The TC combines Human Factors and HRA: the idea is to help both disciplines to work better together, profiting from their complementary perspectives.

An important activity of the TC in the past years has been to support the organization of special technical sessions and panel discussions at the ESREL conferences. These moments of technical exchange create the opportunity for key issues to be raised and discussed. In this context, the recently established HRA Society (http://hrasociety.org/, website under construction) has been very active to organize these events. One example has been last year's panel session "Human factors and human reliability – bridge over troubled water" at ESREL 2011 addressing the relationship between these two disciplines (covered in this newsletter in the September 2011 issue).

The plenary talk at the PSAM – ESREL conference has also addressed some of the key technical issues and recent advancements of the field. A pictorial view can be seen in the "word cloud" below, obtained by collecting the keywords of the papers presented at past ESREL conferences. The cloud highlights some key challenges of the field: the need for assessing HRA methods, a new role for simulator data and the development of context-based HRA approaches. A brief overview was given in the talk. In particular, lately, a major role for the HRA field development was played by the International HRA Empirical Study, a collaborative effort under the auspices of the OECD Halden Reactor Project and probably the most

spectacular initiative in the HRA field in the latest years. In the International HRA Empirical Study, a diverse set of HRA methods were assessed based on data obtained in a dedicated the simulated emergencies performed at the Halden Man-Machine Laboratory (HAMMLAB), in Norway. The study allowed a review of the strengths and weaknesses of the various HRA methods as well as the derivation of methodological insights on assessing and benchmarking HRA methods (see references for further reading).

It is our intention to continue fostering the organization of technical events at the upcoming ESREL conferences and in other relevant events for the safety and reliability community, maintaining the high quality of the discussions and hitting the key topics for advancing in the field. If interested in participating and promoting these activities you are warmly invited to join this ESRA Committee and the HRA Society.

References

- International HRA Empirical Study, US Nuclear Regulatory Commission, NUREG/IA-0216 (Vol. I-III) and OECD Halden Reactor Project, HWR-844 (Vol. I), HWR-915 (Vol. II), HWR-915 (Vol. III).

- The International HRA Empirical Study –Final Report – Lessons Learned from Comparing HRA Methods Predictions to HAMMLAB Simulator Data US Nuclear Regulatory Commission, NUREG-2127 and OECD Halden Reactor Project, HPR-373

ESRA Technical Committee New Chairman

Emanuele Borgonovo
Department of Decision Sciences
Bocconi University

I take the occasion to thank the ESRA chairman, prof Enrico Zio, and the chairman of the ESRA Technical Committee on Uncertainty Analysis, Dr Stefano Tarantola for the opportunity of undertaking this prestigious task, which I take with responsibility and commitment. The objective of this Technical Committee (http://www.esrahomepage.org/uncertainty.aspx) is a particularly challenging one: *to foster research on new methodologies and innovative applications of Uncertainty and Sensitivity Analysis of simulation models.* This is especially true in the light of the increasing complexity of our codes and their increased utilization. Forecasts produced by mathematical models pervasively enter decision-making and regulatory processes that range from the risk analysis of complex systems to that of natural hazards. New and traditional approaches are being developed to improve our ability in model corroboration, model simplification, model output uncertainty reduction, parametric estimation. This motivates the need to welcome diverse approaches, both in uncertainty, sensitivity analyses and model emulation, to enrich the set of tools available to modelers and decision-makers. We have also a rich tradition of summer schools and special sessions at our relevant conferences, as well as the publication of papers in Reliability Engineering and System Safety, which shall help us achieving these goals.

Calendar of Safety and Reliability Events

Advances in Risk and Reliability Technology Symposium

Leicestershire, United Kingdom,
21 - 23 May 2013

The 20th AR^2TS will be an international forum for presenting and discussing recent advances made in the general area of reliability, risk, availability and maintainability. Contributions will be provided from both the university sector and from industry. It will be of benefit to both practitioners and academics involved in this field who want to keep in touch with the latest developments and perhaps through discussion, influence the future direction of work.

The event is organized by Loughborough University and the University of Nottingham, in collaboration with: The Safety and Reliability Society and The Institute of Mechanical Engineers .

Important dates

31 October, 2012 - Deadline for receipt abstract.
5 November, 2012 - Informed of provisional acceptance and full paper requested.
4 February, 2013 - Deadline for receipt of full draft papers.
4 March, 2013 - Notification of final acceptance of papers.
15 April, 2013 - Deadline for receipt of final papers.
Conference Website:

www.nottingham.ac.uk/engineering/conferences/ar2ts

22nd SRA-European Annual Conference

Trondheim, Norway
17 - 19 June 2013

The theme of the conference is "Safe societies – coping with complexity and major risk", concerning challenges related to our society's vulnerability to major risk of natural and industrial disasters, malicious attacks, financial breakdowns and epidemic diseases.
The conference is open to all interested researchers, experts and industry representatives interested in risk analysis, including risk assessment, characterization, communication, management, and policy across all sectors and societal levels.

Important dates

15 January, 2013 - Deadline for submission of abstract and symposia.
1 June, 2013 - Deadline for submission of optional full length papers

Conference Website: www.srae2013.no

2nd International Conference on Transportation Information and Safety - ICTIS 2013

Wuhan, China, 28 June - 1 July

Conference Website: www.ictis-online.org:8080/ictis

8th International Conference on Mathematical Methods in Reliability: Theory, Methods, and Applications - MMR2013

Stellenbosch, South Africa, 1-4 July

The theme of MMR 2013 is "Reliability: A View of the Past and Ideas for the Future" . It aims at enhancing international exchanges and promoting advances in reliability/risk theories and techniques, and organizing an international forum on emerging issues in reliability engineering and risk management. We sincerely hope that you can join us for a rich experience in this unique environment.

Conference Website: www.sastat.org.za/mmr2013

4th International Conference on Risk Analysis and Crisis Response (RACR 2013)

Istanbul, Turkey, 27-29 August

Important dates

Deadline	Notification
Special session proposals	1 December 2012
	1 January 2013
Abstract submission	1 February 2013
	15 February 2013
Paper submission	1 April 2013
	15 April 2013
Final paper due	1 May 2013

Contact

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2013 Prognostics and System Health Management Conference - PHM 2013

Milan, Italy, 8-11 September 2013

Presentation of developments in various industrial fields is expected to highlight differences in research challenges and practical needs, while at the same time beneficiating from cross-fertilization of methods and applications.

The event is organized by AIDIC, The Italian Association of Chemical Engineering.

Details on the Conference may be found at http://www.aidic.it/phm>www.aidic.it/phm

The First Deadline for Abstract Submission is: **23 October, 2012**

Submission of abstracts can be done electronically at

http://www.aidic.it/phm/abstractsubmission.html>http://www.aidic.it/phm/abstractsubmission.html

Accepted papers presented during the Conference will be published in Chemical Engineering Transactions http://www.aidic.it/cet>http://www.aidic.it/cet. The quality of this publication is valued by ISBN & ISSN numbers, referenced by SCOPUS and THOMSON REUTERS (ISI Web of Knowledge, conference proceedings) indexes.

Also, the extended version of selected papers presented at the Conference will be proposed for special issues on indexed scientific journals.

For any further information or assistance you may contact the secretariat at phm@aidic.it.

Important dates

October 23, 2012 - Abstract Submission
November 23, 2012 - Abstract Acceptance
January 23, 2013 - Full Paper Submission
March 23, 2013 - Notification of Acceptance/Rejection
April 3, 2013 - Notification of lecture/poster presentation
May 23, 2013 - Final revised manuscript submission and Registration deadline for Authors to have the paper included in final program and proceedings

Secretariat

Correspondence should be addressed to AIDIC Secretariat:
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Conference Website: www.aidic.it/phm

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

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- 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
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- Technical University of Ostrava, Czech Republic
- Technical University of Liberec, Czech Republic
- University of Defence, Czech Republic
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The Management Board is composed of the ESRA Officers plus one member from each country, elected by the direct members that constitute the National Chapters.

4 Standing Committees

4.1 Conference Standing Committee

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

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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.

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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.
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For application for membership of ESRA, please contact the general secretary **Pieter van Gelder**, E-mail: P.van.Gelder@ct.tudelft.nl.
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