



European Safety and Reliability Association

Newsletter

<http://www.esrahomepage.org>

March 2011

EDITORIAL



*Enrico Zio
ESRA Chairman
Politecnico di Milano, Italy
Ecole Centrale Paris,
Supelec*

Dear ESRA member,

I want to thank you for giving me the privilege of chairing your Association for the next two years. I realize that with the honours come also the duties, and together with the other Officers we are committed to continue the work done by the previous Officers to make sure that ESRA remains a leading community formed by competent scientists and expert practitioners, specialized on methods and applications for safety and reliability and capable of significant advancements in these fields.

In today's World characterized by fast-pace, fast-changing, multidisciplinary technical, financial and economical challenges it is an ethical duty for an Association like ESRA to play a reference and steering role.

For this, ESRA offers a number of activities and initiatives which is important to animate with sound technical content, human enthusiasm and participatory spirit.

The major activity is the ESREL Conference series, which has now passed the 20-events mark. Each year, the ESREL Conference is organised by a group of

“ESRA” and “local” volunteers which put their hearts, souls and bodies in the technical and logistic organization of such a major event. At this event, a community of around 350 peers meet and share their technical competences, professional expertises and life experiences within a work intensive and social pleasant environment: we talk, we listen, we laugh, we share; this is what a community is about. As part of this community, we are looking forward to have you among the volunteers!

Another important activity for continuous sharing is that of the ESRA newsletter. In this respect, we aim at timely providing you with four issues per year dense of technical contents and news in the field of reliability and safety of your interest. For this, we have established a structured calendar for publication: the calendar looks good and we are motivated to try to stick with it; yet, the newsletters can still remain empty of contents if you do not actively contribute. Watch out, as we will soon “call you on duty”!

ESRA provides works as a technical community through its Technical Committees (TCs) and National Chapters (NCs). The objectives of the former are to:

- Provide an arena for contacts and dialogs within a defined subject area, and in this way promote the advance of knowledge in the field.
- Stimulate such contacts and dialogs by paper submissions to dedicated sessions at the ESREL Conferences.
- Provide information/knowledge sharing to the ESRA newsletter.

A decision was made by the Officers to revise the Chairs of all Technical Committees (TCs) every

second year, in an effort to “keep fresh” the animation of the TCs in the direction of the objectives above.

NCs are an important pillar for ESRA local relations and activities; they provide the motivation and energy for:

- Organizing Chapter activities (national workshops, seminars, etc.).
- Attracting participation of members of the National Chapter to the ESREL Conferences.
- Stimulating reporting of activities and points of interest in the ESRA newsletter.

NC Chairs are elected by the members: there, also, it is expected that the animation of the activities be guaranteed, by proper rotation as needed.

The activities of TCs and NCs can find partial financial support from ESRA, within the budget affordable by the Association. For this, a yearly budget is established by the Officers and a call for requests is launched every year. The Officers will then evaluate the requests in view of the objectives of the Association and the expected impact of the activities proposed.

As the budget for these activities come mainly from the ESRA membership fees, we warmly invite you to continue being member of ESRA and to pay the fees timely, so as to allow the timely planning and support of the ESRA activities. For this reason, in November 2010 we have sent you the form for renewal of your membership for 2011, asking you to proceed before the end of 2010.

Also, as normal, ESRA is continuously looking at attracting new members from universities and research organizations, associations, companies and professional organizations, who are interested in sharing their experience and competence with and within our community. For this reason, we ask you to take the initiative of looking for potential new members: ask us for the newly prepared leaflet of presentation of the Association and the form for associating to ESRA, and go out to catch new members willing to contribute to the growth of our field.

Let me conclude by stating that ESRA is an association made of people, made by you, and while I commit myself to continue working for offering you the services that you need, at the level of quality which you expect, I also expect nothing less than the best from you because that is what is needed for ESRA to continue making an impact.

Thank you for continuing ESRA and making it grow.

Enrico Zio
Chairman of ESRA

CONTRIBUTIONS FROM ESRA TECHNICAL COMMITTEES

Review and discussion of basic concepts and principles in integrated risk management



*Terje Aven
University of Stavanger, Norway*

I have led the ESRA Technical Committee on Integrated risk management for two years. Here are some reflections related to work concerning fundamental concepts and principles in integrated risk management (these reflections are my own and not necessarily shared by any of the members of the Technical Committee).

At the ESREL 2009 conference in Prague a subgroup of the technical committee presented a paper where some common standards on risk management were reviewed and discussed (Ale et al 2010). International standards can be seen as a tool for obtaining consensus on what good concepts, principles, methods and models are, and are therefore important for the development of the field. The work covered inter alia the AS/NZS 4360 Risk Management Standard and the COSO Enterprise Risk Management Framework. Ale et al. (2010) conclude that these standards are broadly similar when it comes to basic underlying ideas. Considerable agreement exists on the steps needed for proper risk management: from the definition of critical functions to risk assessment, risk evaluation and risk control. However, it is also concluded that the standards' scientific basis deserves further work. The frameworks are, for instance, unclear about the meaning and understanding of fundamental concepts, including risk and probabilities.

Consider the following definitions of risk (Aven 2011):

- The AS/NZS 4360 Risk Management Standard (AS/NZS 2004):
Risk is defined as the chance of something happening that will have an impact upon predefined objectives. Risk is measured in terms of consequences and likelihood. Likelihood is used as a general description of probability or frequency.
- ISO 31000 standard on risk management (ISO 2009a) and the ISO guide 73 on risk terminology (ISO 2009b): Risk is the effect of uncertainty on objectives. An effect is a deviation from the

expected (positive and/or negative). Risk is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence. Likelihood is defined as the chance of something happening, whether defined, measured or determined objectively or subjectively, quantitatively or qualitatively, and described using general terms or mathematically (such as a probability or a frequency over a given time period). Probability is defined as a measure of the chance of occurrence expressed as a number between 0 and 1 (ISO 2009b). Uncertainty is considered the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequences or likelihood.

But what does it mean that risk is the effect of uncertainty on objectives? Risk has to do with uncertainty, but is it the effect of uncertainty? And risk is related to objectives, but what if objectives are not defined? Then we have no risk? Asking experts on risk, it is no doubt that this definition would lead to numerous different interpretations. The definition per se is not sufficiently precise, and one may certainly also question its rationale as indicated. See discussions in Aven (2011) and Leitch (2010).

In the standards/guidelines, the concepts of likelihood, probability and chance are not precisely defined, and one concept is explained by the other; for example, in the ISO guideline likelihood is defined as the chance of something happening, and probability is defined as a measure of the chance of occurrence, but what is the meaning of a chance? Referring to concepts as probability and chance is not sufficient as these terms can be interpreted in different ways. And depending on the chosen interpretation, we are led in different directions for understanding and assessing risk.

These are observations and issues that can be raised concerning the definition of the risk concept. We have identified a number of other issues in relation to other definitions in these standards/guidelines, for example vulnerability, hazard, risk identification and risk description. See Aven (2011). Through reformulation of some the definitions it is shown in Aven (2011) that it is possible to establish a meaningful, logical and consistent terminology for risk assessment and risk management.

References

- Ale, B., Aven, T., Jongejan, R.B. (2010) Review and discussion of basic concepts and principles in integrated risk management. In R.Bris, C.G. Soares, S.Martorell (eds.) Reliability, Risk and Safety, theory and applications, ESREL2009: pp. 421-427.
- AS/NZS (2004) Risk Management Standard, AS/NZS 4360: 2004. Jointly published by Standards Australia International Ltd, Sydney & Standards New Zealand, Wellington.

- Aven, T. (2011). On the new ISO guide on risk management terminology. Reliability Engineering & System Safety. doi:10.1016/j.res.2010.12.020.
- ISO (2009a) Risk Management – Principles and guidelines, ISO 31000:2009.
- ISO (2009b) Risk Management — Vocabulary. Guide 73:2009.
- Leitch, M. (2010) ISO 31000:2009—The New International Standard on Risk Management. Risk analysis, 30 (6), 887-892.

FEATURE ARTICLES

Using Bayesian Networks for Reliability Management



*M.J.H.A. Houben (TU/e),
PhD student,
TU Eindhoven, IE&IS,
The Netherlands
m.j.h.a.houben@tue.nl*

In the capital goods industry, the availability of a system is very important. As an example, the costs of the downtime of a system form up to 41% (!) of the total costs of ownership (TCO) [1]. Note that this is a conservative estimate [2].

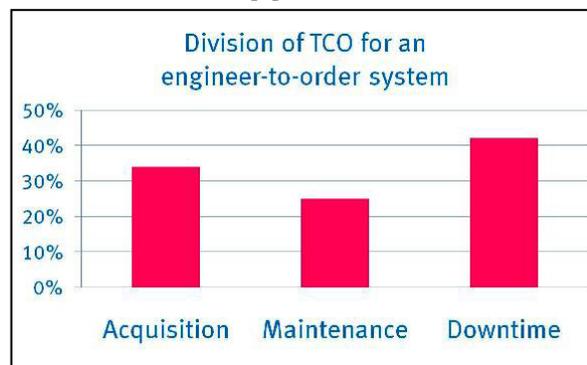


Figure 1 [2]

An example of an industry where the availability plays a major role is the aerospace industry. The availability of airplanes plays an important role for airline companies. It is a strong determinant of the revenues of airlines. Although there are external factors that play a role, and cannot be influenced (like e.g. the volcanic ash that made aviation impossible for a long period of time), there are also a lot of factors that are possible to control. In the aerospace industry, airplane engines play an important role. These engines are typically products for which the availability is very important. Rolls-Royce, a producer of airplane engines uses this fact for their benefit. Instead of engines, they sell flying hours; this is the so-called “power-by-the-hour[®]” concept. In this way, airline companies are able to outsource the

control of the availability, and focus on their core business.

Rolls-Royce, which has to provide availability, is dependent on the reliability of the motors for the control of availability. It is therefore very important for a company as Rolls-Royce to manage reliability throughout the product development process, so that it can provide availability for acceptable costs. Because the costs of possible design changes rise as the product development process progresses, ([3], referring to [4]), it is important to make design changes as soon as possible in the product development process, and by doing that, warrant for the reliability. This identifies the trend to manage reliability as soon as possible in the product development process. Together with this trend, there is a trend that reliability becomes less and less determined by the technical specifications of the components of the products, and that non-technical factors and factors that are difficult to measure or cannot be measured play an increasingly important role, because of the increasing complexity of the products. Since the time pressure on the product development process also increases, it is becoming more and more important to take these factors into account. In this way the management of reliability can be started as soon as possible in the development process.

Management of reliability is often based on implicit insights, visions and perceptions of the people that are involved in the product development process. In my research, I have tried to make these insights explicit, by developing a model that is based on the experience and knowledge of the involved people. In this approach towards reliability management, there is a possibility to proactively realize a desired level of reliability. In this way, the costs for design changes, which increase through the product development process, can be kept low. This can result in higher revenues for the manufacturer, or in lower procurement costs for customers (or both).

In order to make the experience and knowledge of the people explicit, a modeling technique is needed that is able to 'translate' this experience and knowledge into the shape of a model. For this purpose, I have chosen for Bayesian networks. A number of reasons can be mentioned that make Bayesian networks preeminently appropriate for modeling reliability as a 'consequence of the product development process'. The four most important ones are the following:

1. The technique can support decision making processes. This is because they are structural, rather than black box models [5]. This means that they are based on insights and logical relations, rather than purely on collected data. In this way, it is possible to represent reality in an understandable way.
2. The technique is capable of take up the before-mentioned non-technical as well as technical factors up in the model.

3. The technique is usable in the early stadia of the product development process, so that the management of reliability can be started already early in the process. Moreover, they can be used throughout the product development process, and data can be added into the model at the moment as they become available.
4. Bayesian networks use probability theory as basis for their reasoning process. Therefore, they are especially suitable to take the uncertainty into account that plays a role in the product development process.

In my research, the modeling process is the main topic, not the model that gives handles for the management of reliability in the early stages of the product development itself. The central point is the choice for using the decision making process by the people involved in product development as the starting point of the modeling process, contrary to the end result of the process, i.e.: the resulting product. At the same time, this means that the focus lies on making process decisions on a tactical level, rather than decisions on an operational level related to the product design.

In order to involve the people that are involved in the decision making process in the modeling process, I have performed a case study within a business unit of a company. In this case study, I have interviewed 26 different people. Analysis of these interviews has led to the identification of a number of factors that are determinant for the reliability (in the context of the specific business unit of the company). By using the input that was provided by the people in the interviews the model can be based on the knowledge and experience of the involved people.

In this context an important comment has to be made. Because the model is based on the input of people the model is a reflection of the opinions and beliefs of these people; it is difficult to validate the model. Especially because the model reflects the sum of knowledge and experience of a large group of people, validation becomes difficult. Looking at validation, it relates to testing whether the model is a correct representation of the beliefs of the involved people. The problem in this situation is that the single model mirrors the belief of a group of people. Because the group is a collection of a number of individuals, and because the belief of the group is not objectively measurable, validation of the model is very difficult. Moreover, the inclusion of non-technical and non-measurable factors in the model hinders the validation process, since this type of factors is not objectively measurable.

In order to validate the model, an option is validation through a focus group meeting. This means that a group is involved in the validation of the model, consisting limited number of individuals, which are all able to look at the model from different perspectives (having different roles in the product development process). Since the group consists of a

number of individuals that represent different disciplines in the organization, they can provide a representation of the belief of the group (to a certain extent). In this way, the model can be subjectively validated. Because of the fact that the model is being used by people, and is based on the input of people, this is a representative way of validating the model, and should be seriously considered. However, possibly even more important is the acceptance of the model by the people that are involved in the product development process, since the model has to be supported and used by them.

During the validation session in the case study, the focus group provided feedback on the validation process and on the acceptability of the model itself. An important remark that was made was the fact that factual/objective data would increase the acceptability of the model. In this way, the use of the model would be stimulated and get more attention.

The author gratefully acknowledges the support of the Innovation-Oriented Research Programme ‘Integrated Product Creation and Realization (IOP IPCR)’ of the Netherlands Ministry of Economic Affairs

References

[1] Öner, K.B., Franssen, R., Kiesmüller, G.P., Van Houtum, G.J., 2007, Life cycle costs measurement of complex systems manufactured by an engineer-to-order company, in: Qui, R.G., Russell, D.W., Sullivan, W.G., Ahmad, M. (eds.), *The 17th International Conference on Flexible Automation and Intelligent Manufacturing, Philadelphia*, pp.589-596.

[2] Van Houtum, G.J., 2010, Maintenance of capital goods, *Inaugural lecture*, Eindhoven University of Technology.

[3] Rothwell, R., 1994, Towards the Fifth-generation Innovation Process, *International Marketing Review*, Vol. 11, No. 1, pp. 7-31.

[4] Sommerlatte, T., 1991, Raising Technology Development Productivity, *Product and Process Innovation*, Vol. 1, pp. 12–16.

[5] Mitchell, G., 1993, *The practice of operational research*, Wiley, Chichester.

Valuation of immaterial damages in flooding in the Netherlands: fatalities, injuries and evacuations



*M.Bockarjova,
P.Rietveld,
E.T.Verhoef*
VU Amsterdam, FEWEB,
Department of Spatial Economics

The purpose

In the context of a cost-benefit analysis (CBA) of flood protection measures that is being carried out in the Netherlands at the moment (WV21), a team of economists at the VU University Amsterdam has undertaken a research into the monetary valuation of immaterial damages connected to a flood event (Bockarjova et al. 2010). Expressing immaterial damages in monetary terms is required to make these comparable with other cost and benefit indicators used in CBA. In this study, we have considered three aspects of immaterial damages: avoided fatalities, avoided injuries and avoided preventive evacuations.

The method

Valuation of immaterial damages was done by means of conducting a large-scale questionnaire where respondents were asked to make choices within a given situation. So, a group of respondents (about 500 persons) have completed so-called “stated choice” experiments, in which a number of choice cards with varying risk levels and monetary attributes were offered in order to elicit their willingness to pay for risk reductions connected to a flood event. The valued changes in fatality risk were performed around currently existing levels of risk (in the range of 10⁻⁶ to 10⁻⁵ per year). Such low levels of risk valued are relatively unusual in economic valuation exercises, and require particular caution as respondents are required to make ‘informed choices’. To ensure that, current flood risks were explained before choice cards were offered. Alongside with the valuation of fatality risks, the current study has also undertaken a separate simultaneous valuation of risk of injury and risk of evacuation. The study thus produces estimates for the value of statistical life (VOSL), value of statistical injury (VOSI), and value of statistical evacuation (VOSE). This type of research is new not only in the Netherlands, but also for flood risk and hazard research internationally.

Table 1. Summary estimated values of VOSL, VOSI and VOSE

	Estimated average values	
	Lower bound	Upper bound
VOSL, value of statistical life (per fatality)	6.3 mln €	7.2 mln €
VOSI, value of statistical injury (medium to severe injury)	91,000 €	102,000 €
VOSE, value of statistical evacuation (per person)	2,300 €	2,500 €

Results

The obtained values of VOSL, VOSI and VOSE are summarized in Table 1, and are robust as they remained stable throughout estimations carried out with various statistical models. Numerically, the obtained values are plausible and reflect findings elsewhere in the literature. The reported VOSL is within the “acceptable” range of M€ 2 to 14, found by Kluge and Schaffner (2008) for European studies on risk valuation in various risk contexts.

Table 2. Composite valuation of immaterial damage.*

	Coastal Area	Riverside Area
Mark-up factor for the value of injury per one VOSL **	0.07-0.14	0.07-0.14
Mark-up factor for the value of evacuation per one VOSL ***	0.15 – 0.78	1.02 – 10.18

* Source: Bockarjova et al. (2010)

** Assumed VOSI is 92,000 € and VOSL is 6.8 mln €

*** Assumed VOSE is 2,400 € and VOSL is 6.8 mln €.

Considering the composite valuation of fatalities, injury and evacuation, we have found that taking into account only VOSL as a proxy for all immaterial damages may under certain circumstances significantly underestimate the total value of immaterial damages. The composition of immaterial damages (consisting of values of fatality, injury and evacuation) would further depend on the nature of flood risk in a particular area, such as the coast vs. the riverside (see Table 2). Mark-up factor for the value of injury per one VOSL is about 0.1 (provided, on average, 5 to 10 injured persons are avoided per fatal victim saved). The value of avoided evacuation, however, proved to vary with the type of area and to

depend on the nature of flood danger. For example, as we have shown in Bockarjova et al. (2010), in the riverside areas in the Netherlands where extreme water levels can timely be predicted and the majority of residents can be evacuated, mark-up factor for the value of evacuation would be relatively high, from about 1 and up to 10 per one VOSL depending on the assumptions about such parameters as frequency of evacuations, fraction of evacuated persons per event and the extent of flood (our figures are based on the recent calculations of respective parameters by HKV, 2010). For the coastal areas where storm surges are less predictable and where only a small fraction of inhabitants can be timely evacuated, evacuations surcharge per one fatality would be substantially lower and vary, again depending on the circumstances, from about 15% to 80% per VOSL.

Conclusions

Our inquiry not only yields new insights into the valuation of risks connected to flooding in the Netherlands, but also provides an important contribution to the hazard literature internationally. Our findings are threefold. First, valuation of fatality risk in flood (VOSL=7 mln €) in the Netherlands is higher than the respective indicator obtained in the context of transport safety (VOSL=2.5 mln €) and that is currently adopted in CBA of flood protection measures. This pleads for a higher monetary value of benefits in relation to avoided fatalities connected to better flood protection measures. Second, composite valuation of immaterial damage shows the importance of including differentiated indicators of immaterial damage alongside with valued fatalities (VOSL) in cost-benefit analyses, such as value of statistical injury (VOSI) and value of statistical evacuation (VOSE), which can substantially contribute to the composite value of avoided immaterial damages. We have shown that under some risk conditions the VOSL might make but a fraction of total immaterial damages (Figure 1), and so inclusion of the VOSL alone in a cost-benefit analysis may not be representative of total immaterial damages, and in some cases even significantly underestimate these.

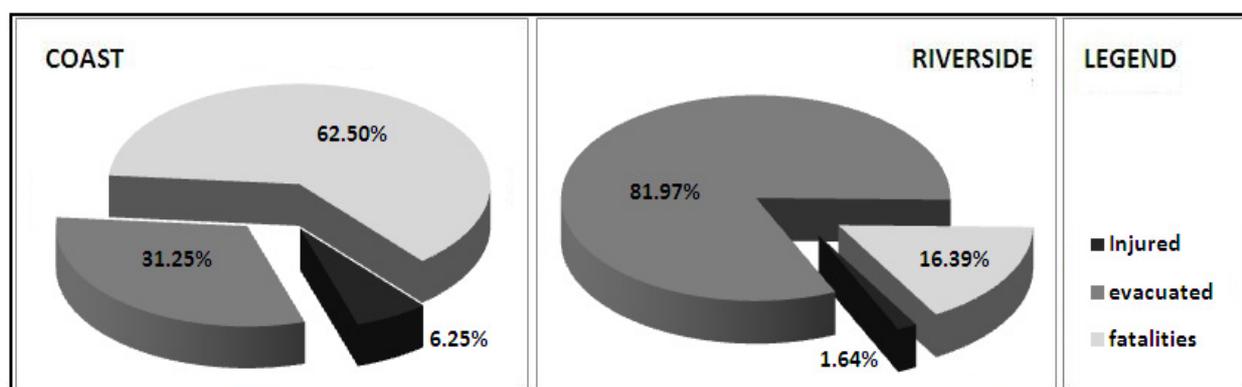


Figure 1. Typical composition of total immaterial damages per dike-ring area type (in percent) at average values of parameters. (Source: Bockarjova et al. (2010))

Finally, the observed discrepancy in the relative weights of various components of immaterial damage between various areas with differing flood risks points at the necessity to consider area-specific immaterial damages when conducting CBA, also provided the effects that particular policy measures may have on the expected height and composition of immaterial damages.

This research was financed by the BSIK project Climate Changes Spatial Planning (Klimaat voor Ruimte, see www.klimaatvoorruimte.nl) and project KBA WV21 from the Dutch Ministry of Transport and Water Management.

References

M. Bockarjova, P. Rietveld, E. Verhoef (2010) Immaterial damage valuation in flooding: value of statistical life, value of evacuation and value of injury. Paper presented at the International conference "Delta's in the Time of Climate Change", 29 September – 1 October 2010, Rotterdam, the Netherlands.

HKV (2010) Kengetallen evacuatie voor kostenbaten analyse, Memorandum PR1919-10.

Kluve, J., and Schaffner, S. (2008) The Value of Life in Europe – a Meta-Analysis; *Sozialer Fortschritt* 10-11: 279-287.

PHD DEGREES COMPLETED

Contributions to the treatment of uncertainty in risk assessment and management



Roger Flage
Department of industrial economics, risk management and planning, University of Stavanger, Norway

Main supervisor:

Professor Terje Aven, Department of industrial economics, risk management and planning, University of Stavanger, Norway

There is a considerable amount of contemporary academic and industrial interest in the treatment of uncertainty in uncertainty and risk analysis and management. This is illustrated, for example, by the organization of several workshops and seminars, and by the publication of several special issues of scientific journals during the last few years, having uncertainty as it relates to uncertainty and risk analysis and management as the main topic.

The thesis deals with the treatment of uncertainty in risk assessment and management, in particular industrial asset risk management. Specifically, three topics are addressed: practices in the treatment of uncertainty in risk assessment and management, alternative representations of uncertainty in risk assessment, and models and methods for the treatment of uncertainty in asset risk management. The thesis is paper-based and consists of nine papers. One paper from each topic is described in the following:

Expected value-based and probability-based risk indices constitute the backbone of the risk characterization typically presented in quantitative risk analyses. This practice often does not properly account for uncertainties 'hidden' in the assumptions and premises (the 'background knowledge') of the analyses. Starting from a risk perspective where risk is seen as the combination of (i) events A and consequences C, and (ii) the associated uncertainties U (will the events occur and what will be the consequences), referred to as the (A, C, U) risk perspective, in one of the thesis papers we describe the link between the basic components of the risk description prescribed by the (A, C, U) perspective and the more operational components used in quantitative risk analyses. Furthermore, we suggest a qualitative classification scheme for uncertainty and sensitivity in such analyses. The overall result is a semi-quantitative approach to risk assessment, and we argue that risk evaluation should extend beyond consideration of the probabilistic risk indices and sensitivity analyses used today.

Uncertainty due to lack of knowledge ('epistemic' uncertainty) and uncertainty due to random variation ('aleatory' uncertainty) are widely recognized as two fundamental features to characterize in risk analysis. Probability is the predominantly used representation for this purpose. However, alternative representations of uncertainty have been suggested for the epistemic uncertainty concept. In a review and discussion of some of the predominant alternative representations of uncertainty, it is found that some of these representations have been associated with interpretations that are less than clear, and that some of the interpretations might not be appropriate in the context of reliability and risk analysis.

Uncertainty due to random variation is usually taken as a fundamental feature of the deterioration of technical systems and components. For systems of this kind it is often desirable to find economically optimal maintenance policies. In the case that the unit to be subjected to maintenance optimization is considered safety critical, the risk associated with a failure may be controlled by putting a safety constraint on the economic optimization. If at the same time the random deterioration process is unknown, we are lead naturally to a Bayesian (adaptive) model. One of the thesis papers shows that then two types of safety constraints can be imposed.

The PhD work has included two research stays abroad – one at Rutgers University, USA, working under the supervision of Professor James T Luxhøj and Professor David Coit; and one at Politecnico di Milano, Italy, working under the supervision of Professor Enrico Zio and Assistant Professor Piero Baraldi.

The research presented in the thesis is a contribution to the research project 'Regularity and uncertainty analysis and management for the Norwegian offshore gas transportation system' (the RAMONA project), sponsored by the Research Council of Norway through the PETROMAKS research programme as well as by the RAMONA project industry partners Statoil and Gassco

Discrete dynamic event tree modelling and analysis of nuclear power plant crews for safety assessment

Davide Mercurio

Risk and Human Reliability Group, Paul Scherrer Institut, Switzerland

Examiners and co-examiners:

Prof. Dr. Wolfgang Kröger, examiner

Prof. Dr. Michael Prasser, co-examiner

Dr. Vinh N. Dang, co-examiner

Current Probabilistic Risk Assessment (PRA) and Human Reliability Analysis (HRA) methodologies model the evolution of accident sequences in Nuclear Power Plants (NPPs) mainly based on Logic Trees. The evolution of these sequences is a result of the interactions between the crew and plant; in current PRA methodologies, simplified models of these complex interactions are used.

In this study, the Accident Dynamic Simulator (ADS), a modelling framework based on the Discrete Dynamic Event Tree (DDET), has been used for the simulation of crew-plant interactions during potential accident scenarios in NPPs. In addition, an operator/crew model has been developed to treat the response of the crew to the plant. The "crew model" is made up of three operators whose behaviour is guided by a set of rules-of-behaviour (which represents the knowledge and training of the operators) coupled with written and mental procedures. In addition, an approach for addressing the crew timing variability in DDETs has been developed and implemented based on a set of HRA data from a simulator study. Finally, grouping techniques were developed and applied to the analysis of the scenarios generated by the crew-plant simulation. These techniques support the post-simulation analysis by grouping similar accident sequences, identifying the key contributing events,

and quantifying the conditional probability of the groups. These techniques are used to characterize the context of the crew actions in order to obtain insights for HRA.

The model has been applied for the analysis of a Small Loss Of Coolant Accident (SLOCA) event for a Pressurized Water Reactor (PWR). The simulation results support an improved characterization of the performance conditions or context of operator actions, which can be used in an HRA, in the analysis of the reliability of the actions. By providing information on the evolution of system indications, dynamic of cues, crew timing in performing procedure steps, situation assessment, and crew challenge, these results are useful and relevant for the analysis of the crew's diagnosis/decision-making and, more generally, of operator cognitive tasks. A comparison of the operator-plant simulation results based on the DDETs with classical PRA/HRA analyses of selected actions found significant differences in the available time for operator actions, dynamic response of the system, and necessary cool-down time. In addition, using grouping techniques, failure and close to failure scenarios have been identified, analyzed, and an assessment of the Performance Shaping Factors (PSFs) has been done to support the calculation of the Human Error Probabilities (HEPs) using insights from the dynamic simulation.

SAFETY AND RELIABILITY EVENTS

ESREL 2010 Safety and Reliability Annual Conference Rhodes, 5-9 September 2010

Ioannis Papazoglou

General Chair of ESREL 2010

National Centre for Scientific Research

"Demokritos", Greece

In 2010 ESREL returned to Greece for the second time with the theme "Reliability, Risk and Safety: Back to the Future". The Conference covered a number of topics within reliability, risk and safety, including risk and reliability analysis methods, maintenance optimisation, human factors, risk management, etc. Application areas ranged from nuclear engineering, oil and gas industry, electrical and civil engineering to information technology and communication, security, transportation, health and medicine or critical infrastructures. Significant consideration was given also to the societal factors influencing the use of reliability and risk assessment methods. Integral demonstrations of the use of risk analysis and safety assessment were provided in

many practical applications concerning major technological systems and structures.

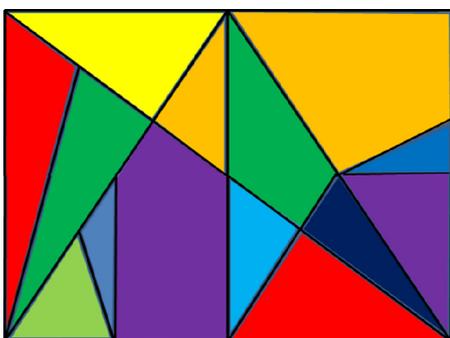
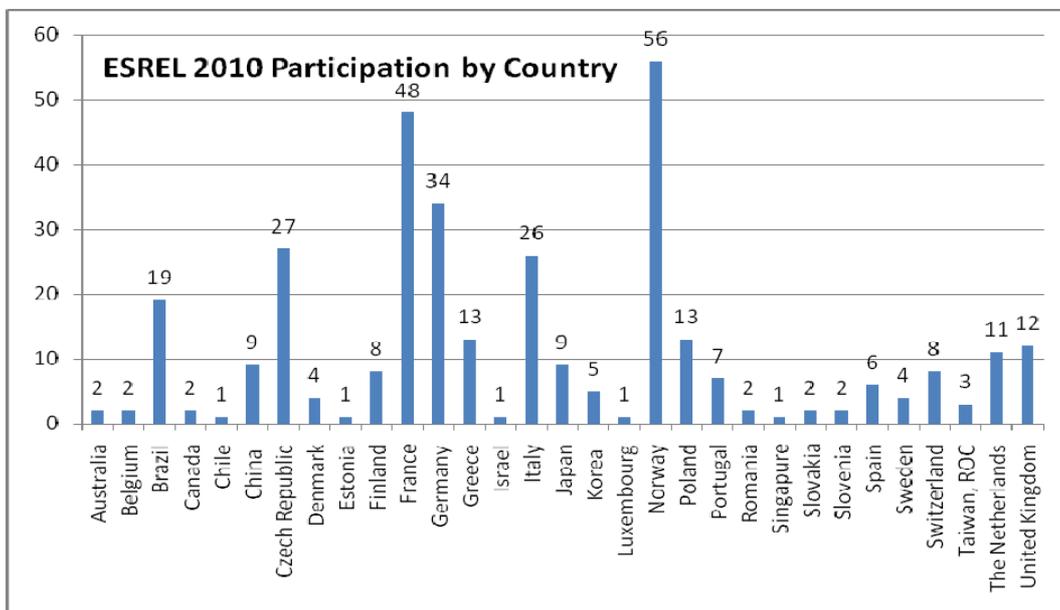
In 1996 the conference was held on the Island of Crete. Another island, the island of Rhodes in Greece has been selected as the venue for ESREL 2010. The return of ESREL to Greece reflects more than two millennia of attempts to come to grips with the notion of probability and risk. Athenians although they did not recognised the concept of probability had grasped the notion of risk management as indicated by the excerpt below.

“We Athenians in our persons, take our decisions on policy and submit them to proper discussion. The worst thing is to rush into action before the consequences have been properly debated. And this is another point where we differ from other people. We are capable at the same time of *taking risks* and *estimating them before hand*. Others are brave out of ignorance; and when they stop to think, they begin to fear. But the man who can most

truly be accounted brave is he who best knows the meaning of what is sweet in life, and what is terrible, and he then goes out undeterred to meet what is to come”.

From Pericles’s Funeral Oration in Thucydides’
“ History of the Peloponnesian War

Later Archimedes occupied himself with the question of how many possibilities there were to lay out 14 pieces of a puzzle called “Stomachion”. It is conjectured that this effort marked the first attempt to theoretical foundation of combinatorics. Since then combinatorial analysis found its way into the analysis of probabilities and risk from which quantified risk analysis developed. Participants of the ESREL 2010 conference did not only look at the latest developments, but also searched for the meaning of the ancestral heritage for today’s world wide problem of managing risk.



Archimedes’ Stomachion with
17152 (=536x32) solutions

The National Centre for Scientific Research “Demokritos” hosted ESREL 2010. “Demokritos” was founded in 1959 with original objective the advancement of nuclear technology for peaceful

purposes in Greece. Since then it has grown to a multidisciplinary research centre covering R&D in the fields of Nuclear Physics, Nuclear Technology Radiation Protection, Material Science, Information and Telecommunications, Microelectronics, Physical Chemistry, Biology and Radioisotopes and Radiopharmaceutical products. “Demokritos” is the largest research centre of Greece spreading over 150 acres near Athens, with 35000m² of buildings having significant research infrastructure in large laboratory facilities, scientific instruments, computer networks and around 900 permanent and on fixed-time contract employees.

Three hundred forty six (346) participants from 32countries spanning four continents attended ESREL 2010. The Conference program included 303 papers. They were presented in 86 sessions in six parallel trails spanning four days. Originally, about 540 abstracts were submitted. An international Technical Programme Committee consisting of

45 members reviewed the submitted work in two stages: first the abstracts and then the full papers; 303 have been accepted and are included in Conference Proceedings.

Thanks to authors as well as reviewers for their contributions in this process. The review process has been conducted electronically through the Conference webpage and we acknowledge the use of the system developed for the ESREL 2006 conference in Estoril, Portugal. This year for the first time the Proceedings were issued only in a CD while a paper book of abstracts helped those that were not willing to carry their laptop around.

Prof. George Apostolakis of MIT and currently Commissioner at the US Nuclear Regulatory Commission gave the opening speech entitled "Managing Uncertainties in the Regulation of Nuclear Facilities: The issue of Unknown Unknowns".



Dr. Ioannis A. Papazoglou past Chairman of ESRA and General Chair of ESREL 2010 welcoming the Conference participants. (Photos of Dr. Papazoglou after the closing of the Conference are not available).



Finally we would like to acknowledge the local organising committee for their careful planning of the practical arrangements.



On the way to the "HRA Society" - Announcement for the 2nd HRA Society Workshop at ESREL 2011

18-22 Sept., Troyes, France

Luca Podofillini

*Risk and Human Reliability Group, Paul Scherrer
Institut, Switzerland*

An effort to establish the Human Reliability Analysis (HRA) Society is underway. The general idea of the Society is to establish a common platform to exchange information on research issues and applications, to define training standards, general networking, and the like. A website is under construction (www.hrasociety.com).

Figure 1 - *The HRA Society*

A first workshop of the Society took place during the 10th International Probabilistic Safety Assessment & Management Conference (PSAM 10, 7-11 June 2010, Seattle, USA): the discussion addressed which needs such a society could satisfy and expectations by the workshop delegates on possible activities. It resulted

that a top need for the society is information exchange and people, including networking.

Application came second, indicating a strong desire to see case studies of HRA applications, reflecting the fact that HRA is an applied discipline, but one where there is need for more guidance by example. Data sharing was third, followed by 'State-of-the-art' (keeping up to date with developments), and standards and standardization. Four lesser needs were journals, training (including coaching of newcomers to HRA), research and 'recognition' for the HRA discipline itself and its proponents and practitioners.

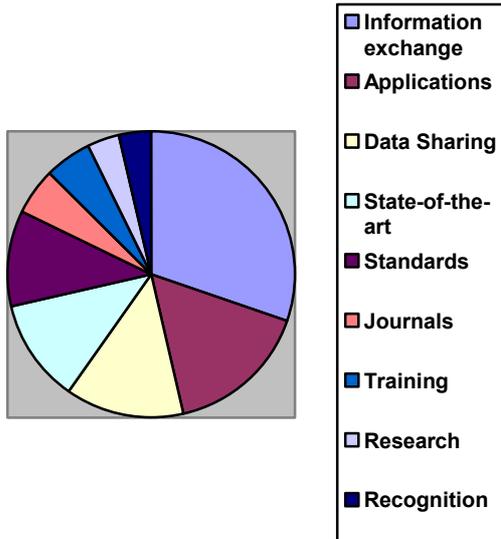


Figure 1 - Needs from an HRA society (votes from a facilitated session during the 1st HRA Society Workshop at PSAM 10).

The organization of the society, memberships and member activities, and future steps were also discussed during the PSAM workshop. A detailed meeting report can be found at <http://www.hrasociety.com>.

The second HRA Society Workshop will be held in connection with ESREL 2011. Topics, aims, and organization of the workshop will be defined in the next months (relevant information will be posted on www.hrasociety.com and <http://www.esrel2011.com>). The workshop will include technical presentations as well as a discussion session to address the status of ongoing activities and planning of the future steps. Interested ESREL delegates are welcome to join.

SAFETY AND RELIABILITY PUBLICATIONS

Advances in Degradation Modeling Applications to Reliability, Survival Analysis, and Finance



Series:
Statistics for Industry and Technology

Editors:
M.S. Nikulin, N. Limnios, N. Balakrishnan, W. Kahle, C. Huber-Carol

In recent years, the studies of performance degradation have attracted many interests and efforts because the degradation measurements contain fairly credible, accurate and useful information about product reliability.

Important research applications of degradation models are in the areas such as reliability, biology and health, micro-electronic components, metals fatigue testing, and other dependable systems / infrastructures.

This self-contained volume examines these tools in chapters written by experts currently working on the development and evaluation of such models and methods.

While a number of chapters deal with estimation and inference in related statistics, several explore more specific connections and recent results in "real-world" degradation, step-stress experiments with lagged effects, censoring data.

New perspectives are presented in the fields of stochastic models for damages and its markers, weakest link principle, and reliability estimation from failure-degradation data with covariates.

Recent results are presented in the following topics:

- * Accelerated testing and inference
- * Nonparametric inference
- * Model validity in accelerated testing
- * The point process approach
- * Bootstrap methods in degradation analysis
- * Exact inferential methods in reliability
- * Dynamic perturbed systems

Advances in Degradation Modeling is an excellent reference for researchers and practitioners in applied probability and statistics, industrial statistics, the health sciences, quality control, economics, and finance.

CALENDAR OF SAFETY AND RELIABILITY EVENTS

Structures, Safety and Reliability Symposium at OMAE 2011

Rotterdam, 19-24 June 2011

The Structures, Safety and Reliability Symposium of the 30th International Conference on Ocean, Offshore

and Arctic Engineering (OMAE 2011) will be held at the World Trade Center in Rotterdam, The Netherlands. Europe's largest port is in Rotterdam and it is base for a large number of world renowned offshore companies.

Visit the Conference website at the following address www.asmeconferences.org/omae2011 to find out more, or contact the Symposium Coordinator, Carlos Guedes Soares, at guedess@mar.ist.utl.pt.

ESREL 2011

European Safety and Reliability Conference

Troyes, 18-22 September 2011

Safety, reliability and risk management become more and more important in an always more challenging and competitive environment, in every industry and human activity: multidisciplinary approaches to safety & reliability engineering and risk management become more and more necessary and attractive. ESREL 2011 conference will provide a forum for presentation and discussion of scientific works covering theories and methods in the field of risk, safety and reliability, and their application to a wide range of industrial, civil and social sectors and problem areas. ESREL 2011 will also be an opportunity for researchers and practitioners, academics and engineers to meet, exchange ideas and gain insight from each other.

Important Dates:

Submission of Abstracts: 15 January 2011

Submission of full-length paper: 31 March 2011

Website: www.esrel2011.com

9th International Probabilistic Workshop

17-18 November 2011

Organization: Technische Universität Braunschweig, Germany & University of Natural Resources and Applied Life Sciences, Vienna, Department of Civil Engineering and Natural Hazards

Submission:

Abstracts: 1 May 2011

Full papers: 19 August 2011

Conference location: Technische Universität Braunschweig, Germany

Further information from Conference Chairmen:

Prof. Harald Budelmann (h.budelmann@tu-bs.de) and Dr. Dirk Proske (dirk.proske@boku.ac.at)

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

1.3 Companies

- ARC Seibersdorf Research GmbH, Austria
- TAMROCK Voest Alpine, Austria
- IDA Kobenhavn, Denmark
- VTT Industrial Systems, Finland
- Bureau Veritas, France
- INRS, France
- Total, France
- Commissariat à l'Energie Atomique, 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
- Segretario generale CNIM, Italy
- TECSA, SpA, Italy
- Dovre Safetec Nordic AS, Norway
- PRIO, Norway
- SINTEF Industrial Management, Norway
- Central Mining Institute, Poland
- Adubos de Portugal, Portugal
- Transgás - Gás Natural, Portugal
- Cia. Portuguesa de Produção Electrica, Portugal
- Siemens SA Power, Portugal
- Caminhos de Ferro Portugueses, Portugal
- ESM Res. Inst. Safety & Human Factors, Spain
- IDEKO Technology Centre, Spain
- TECNUN, Spain
- TEKNIKER, Spain
- TNO Defence Research, The Netherlands
- BP International, UK
- HSE - Health & Safety Executive, UK
- Railway Safety, UK
- W.S. Atkins, UK

1.4 Educational and Research Institutions

- University of Innsbruck, Austria
- University of Natural Resources & Applied Life Sciences, Austria

- Université Libre de Bruxelles, Belgium
- University of Mining and Geology, Bulgaria
- Czech Technical University in Prague, Czech Republic
- Technical University of Ostrava, Czech Republic
- Technical University of Liberec, Czech Republic
- University of Defence, Czech Republic
- Tallin Technical University, Estonia
- Helsinki University of Technology, Finland
- École de Mines de Nantes, France
- Faculté de Polytechnique de Mons, France
- Université Henri Poincaré (UHP), France
- LAAS, France
- Université de Bordeaux, France
- Université de Technologie de Troyes, France
- Université de Marne-la-Vallée, France
- Fern University, Germany
- Technische Universität Muenchen, Germany
- Technische Universität Wuppertal, Germany
- University of Kassel, Germany
- Nat. Centre Scientific Res. 'Demokritos', Greece
- University of the Aegean, Greece
- Università di Bologna (DICMA), Italy
- Politecnico di Milano, Italy
- Politecnico di Torino, Italy
- University of Rome "La Sapienza", Italy
- Università Degli Studi di Pavia, Italy
- Università Degli Studi di Pisa, Italy
- Technical University of Delft, The Netherlands
- Institute for Energy Technology, Norway
- NTNU, Norway
- University of Stavanger, Norway
- Gdansk University, 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, Portugal
- Universidade de Minho, Portugal
- Universidade do Porto, Portugal
- University Politechnica of Bucharest, Romania
- University of Strathclyde, Scotland
- Institute of Construction and Architecture of the Slovak Academy of Sciences, Slovakia
- University of Trencin, Slovakia
- Institute "Jozef Stefan", Slovenia
- PMM Institute for Learning, Spain
- Universidad D. Carlos III de Madrid, Spain
- Universidad de Cantabria, Spain
- Universidad de Extremadura, Spain
- Univ. de Las Palmas de Gran Canaria, Spain
- Universidad Politecnica de Madrid, Spain
- Universidad Politecnica de Valencia, Spain
- Consejo Sup. Invest. Científicas, IMAFF, Spain
- Lulea University, Sweden
- World Maritime University, Sweden
- Institut f. Energietechnik (ETH), Switzerland
- City University London, UK
- Liverpool John Moores University, UK
- University of Bradford, UK
- University of Portsmouth, UK
- University of Reading, School of Construction Management & Engineering, UK
- University of Salford, UK

1.5 Associate Members

- Federal University of Pernambuco, Brazil
- Fluminense Federal University, Brazil
- Universidad Central de Venezuela, Venezuela
- European Commission - DR TREN (transport and Energy), in Luxembourg
- Chevron - Energy Technology Company, in Houston, USA

2 ESRA Officers

Chairman

Enrico Zio (enrico.zio@polimi.it)
Politecnico di Milano, Italy
Ecole Centrale Paris, Supelec

Vice-Chairman

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

General Secretary

Pieter van Gelder (p.vangelder@ct.tudelft.nl)
Delft University of Technology, The Netherlands

Treasurer

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

Past Chairman

Ioannis Papazoglou (yannisp@ipta.demokritos.gr)
NCSR Demokritos Institute, Greece

Chairmen of the Standing Committees

K. Kolowrocki, Gdynia Maritime University, Poland
C. Guedes Soares, Instituto Superior Técnico, Portugal

3 Management Board

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

Chairman: K. Kolowrocki, Gdynia Maritime University, Poland

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.

4.2 Publications Standing Committee

Chairman: C. Guedes Soares, Instituto Superior Técnico, Portugal

This committee has the responsibility of interfacing with Publishers for the publication of Conference and Workshop proceedings, of interfacing with Reliability Engineering and System Safety, the ESRA Technical Journal, and of producing the ESRA Newsletter.

5 Technical Committees

Technological Sectors

5.1 Aeronautics Aerospace

Chairman: Darren Prescott, UK
E-mail: d.r.prescott@lboro.ac.uk

5.2 Critical Infrastructures

Chairman: W. Kröger, Switzerland
E-mail: kroeger@mavt.ethz.ch

5.3 Energy

Chairman: Kurt Petersen, Sweden
E-mail: Kurt.Petersen@lucram.lu.se

5.4 Information Technology and Telecommunications

Chairman: Elena Zaitseva, Slovakia
E-mail: Elena.Zaitseva@fri.uniza.sk

5.5 Manufacturing

Chairman: Benoit Lung, France
E-mail: Benoit.lung@cran.uhp-nancy.fr

5.6 Nuclear Industry

Chairman: S. Martorell, Univ. Polit. de Valencia, Spain
E-mail: smartore@iqn.upv.es

5.7 Safety in the Chemical Industry

Chairman: M. Christou, Joint Research Centre, Italy
Email: Michalis.Christou@jrc.ec.europa.eu

5.8 Land Transportation

Chairman: Valerio Cozzani, Italy
E-mail: valerio.cozzani@unibo.it

5.9 Maritime Transportation

Chairman: Jin Wang, UK
E-mail: J.Wang@ljmu.ac.uk

5.10 Natural Hazards

Chairman: P. van Gelder, The Netherlands
Email: p.h.a.j.m.vangelder@tudelft.nl

Methodologies

5.11 Accident and Incident Modelling

Chairman: Stig O. Johnson, Norway
Email: stig.o.johnsen@sintef.no

5.12 Prognostics & System Health Management

Chairman: Piero Baraldi, Italy
E-mail: Piero.baraldi@polimi.it

5.13 Human Factors and Human Reliability

Chairman: Luca Podofillini, Switzerland
Email: Luca.podofillini@psi.ch

5.14 Maintenance Modelling and Applications

Chairman: Christophe Bérenguer, France
Email: christophe.berenguer@utt.fr

5.15 Mathematical Methods in Reliability and Safety

Chairman: John Andrews, UK
Email: John.Andrews@nottingham.ac.uk

5.16 Quantitative Risk Assessment

Chairman: Marko Cepin, Slovenia
E-mail: marko.cepin@fe.uni-lj.si

5.17 Systems Reliability

Chairman: Gregory Levitin, Israel,
E-mail: levitin@iec.co.il

5.18 Uncertainty Analysis

Chairman: Stefano Tarantola, Italy,
E-mail: stefano.tarantola@jrc.it

5.19 Safety in Civil Engineering

Chairman: Raphael Steenbergen, The Netherlands
Email: Raphael.steenbergen@tno.nl

5.20 Structural Reliability

Chairman: Jana Markova, Czech Republic
E-mail: Jana.Markova@klok.cvut.cz

5.21 Occupational Safety

Chairman: Ben Ale, The Netherlands
Email: B.J.M.Ale@tudelft.nl



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.org>.

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

The objective is to publish the ESRA Newsletter quarterly. Please submit information to the ESRA Newsletter to any member of the Editorial Board, preferably one month before the publication date:

Editor: Carlos Guedes Soares – guedess@mar.ist.utl.pt
Instituto Superior Técnico, Lisbon

Editorial Board:

Ángelo Teixeira - teixeira@mar.ist.utl.pt

Instituto Superior Técnico, Portugal

Antoine Grall – antoine.grall@utt.fr

University of Technology of Troyes, France

Dirk Proske – dirk.proske@boku.ac.at

University of Natural Resources and Applied Life Sciences, Austria

Giovanni Uguccione - giovanni.uguccioni@dappolonia.it

D'Appolonia S.p.A., Italy

Igor Kozine – igko@risoe.dtu.dk

Technical University of Denmark, Denmark

Sylwia Werbinska – sylwia.werbinska@pwr.wroc.pl

Wroclaw University of Technology, Poland

Lars Bodsberg – Lars.Bodsberg@sintef.no

SINTEF Industrial Management, Norway

Luca Podofillini – luca.podofillini@psi.ch

Paul Scherrer Institut, Switzerland

Marko Cepin - marko.cepin@fe.uni-lj.si

University of Ljubljana, Slovenia

Paul Ulmeanu - paul@cce.fiab.pub.ro

Univ. Politehnica of Bucharest, Romania

Radim Bris – radim.bris@vsb.cz

Technical University of Ostrava, Czech Republic

Sebastián Martorell - smartore@iqn.upv.es

Universidad Politécnica de Valencia, Spain

Martijn Flinterman – martijn.flinterman@rws.nl

The Netherlands Soc. for Risk Analysis & Reliability

Uday Kumar - uday.kumar@ltu.se

Luleå University of Technology, Sweden

Zoe Nivolianitou – zoe@ipta.demokritos.gr

Demokritos Institute, Greece

Zoltan Sadovsky - usarzsad@savba.sk

USTARCH, SAV, Slovakia