European Safety and Reliability Association

ESRA Newsletter

http://www.esrahomepage.org

May 2005

ESRA NEWS

Letter from the Chairman

Carlos Guedes Soares

IST – Portugal

Time to Change

Organisations like ESRA are served by volunteers that dedicate their time and effort to the various activities in order to permit the Association to pursue its objectives. This work is limited in time, to ensure the required rotation of responsibilities and the corresponding new impulses that are essential for the progress of the Association.

My second term as Chairman comes to an end at the Next General Assembly and a new team will be taking over the responsibility of running the Association.

In a way, the end of this mandate completes a cycle that I started as one of the five founding members of the Association. I held the position of General Secretary for about nine years, followed by the position of Vice-Chairman before taking up the present responsibilities as Chairman.

Much has happened during this period but ESRA has survived the initial years against all the odds and the scepticism about its potential to develop. ESRA is now solidly established with its well know annual ESREL Conferences and with a total membership of more than 90 institutions, which is increasing every year.

It is a very difficult and lengthy process to introduce changes in an international organisation of this nature. Ideas take time to mature and changes in organization take a significant amount of time to become effective. During the last mandate I have tried to implement several initiatives that have been suggested and accepted a while ago but in various cases it was not possible to have them completed. However, I hope that many of the initiatives that have not been fully accomplished in the present mandate, will be further continued and strengthened in the coming years.

An important initiative, in my opinion, was the creation of new Technical Committees that correspond to the Thematic Areas and Industrial sectors around which the ESREL Conferences are based. The main objective of this change was to set up a direct line between the work of the Technical Committees and the contents of the ESREL Conferences. The members of each Committee would take a stronger role in the Conference by directing their output more towards the Conference instead of independent workshops, and also take a more active part in reviewing the papers in their subject area and in chairing the respective sessions, i.e. they would take a more direct participation in the Conference Technical Programme Committee.

Some new Committees have been created but not all the required ones are in place. I hope that this process will continue and that with ESREL 2006 the convergence will be accelerated.

Another important item is the process to establish the requirements for an institution to host ESREL Conferences. The Conferences Standing Committee has made progress in producing a document that clearly establishes the relationship between the Local Organiser of the Conference and ESRA, but although advances have been made, a final form has yet to be approved. I hope that this can be finalised soon so that clear guidelines will be available for the local organizers of ESREL 2007.

Significant changes have been achieved in the area of the Association's publications. Elsevier has made available personal subscriptions of the Journal Reliability Engineering and System Safety at very much reduced rates for members of the ESRA Committees, and I hope that this will be seen as an incentive for those who participate in the Committees.

ESRA has also reached an agreement with A.A.Balkema, which now has been incorporated into the Francis & Taylor Group, for producing a series of ESRA books that will be available to ESRA members with a 35% discount. This series will include the ESREL proceedings, most of which have indeed been published by them, and will also initiate a new series of workshop proceedings and of textbooks. For the series of ESRA books, it is required to establish an Editorial Board, which hopefully will be established during 2006.

Finally, the Newsletter is trying to appear more frequently although this has not yet been achieved. We are aiming to have six issues per year but it has not yet been possible to have them ready on time, as the contributions are not flowing-in as desired. It has been hoped that the ESRA Technical Committees would contribute more with brief Feature Articles and that the National Associations and members of the Newsletter Editorial Board would be active in providing news and input from their respective countries.

I hope that the new ESRA Management Team will be able to complete the implementation of these initiatives and promote new ones.

As my mandate comes to an end, I would like to recognise the contributions of my colleagues Enrico Zio, Palle Christensen and Pieter van Gelder, who were essential elements for the work accomplished.

In the near future, I plan to be dedicating more attention to the ESRA publications and I will be supporting the new management team as well as I can in the function of Past Chairman.

CONTRIBUTIONS FROM ESRA TECHNICAL COMMITTEES

Italian Experiences of QRA in Land Transportation of Dangerous Substances

Gigliola Spadoni,
University of Bologna,
Italy

Chairman,
ESRA Technical Committee on Safety of Land Transportation

Introduction

European regulations concerning safety in transportation of dangerous substances by rail and road are addressed to guarantee a "safe vehicle" by defining design parameters and device characteristics, both obviously dependent on the hazard class of the transported substance. Information and training of the driver complete the set of measures directed to reduce hazards related to such types of transport.

Nevertheless a complete and quantitative knowledge of risk posed to people requests to integrate information about three different objects: the vehicle (and the driver), the way, road or rail, and the territory crossed. Feasible, and quite easy, is the imposing of common rules on the transport mean, while way and territory involved depend on origin and final destination and can differ even with the same destination. Consequently, even if there was the will, it should be difficult, or practically impossible, to define a regulation similar to that in force for the industrial establishments which store or process dangerous substances. This law requests, in the context of a safety management system, a qualitative or quantitative risk analysis as the best tool to identify protection and, above all, prevention measures.

In this framework the QRA applied to HazMat transportation becomes a voluntary tool that a public authority, a local administration or a company can use to gain a deep knowledge of hazards provoked by industrial activities. From these considerations are born some projects concerning transport risk analysis in Italy. Just to give a picture of the main characteristics of such projects, the attention is here focused on two of them. Results of other ones of the same importance can be found on open literature.

HazMat transportation on road: a regional experience

Since 1990 the Civil Protection Service of the Emilia-Romagna Region had supported (the first supporter being the Italian Department of Civil Protection) risk analysis activities within ARIPAR[1] Project born to gain, through a deep knowledge, suggestions for increasing safety of Ravenna town citizens. As a matter of fact such activities based on risk assessment are in complete agreement with the law n.45/95 of Emilia-Romagna Region, which has introduced the criterion of evaluating the vulnerability of territorial areas subject to specific risks as a fundamental step of its prevention activity.

One year ago the Service decided to start a Project on transport of dangerous substances, in order:

- to collect data on which types of substances and how many amounts pass through the Region;
- to identify points and routes of the regional network where the hazards are greater through an analysis of occurred incidents;
- to analyze risks posed on the territory carrying out a QRA procedure and mapping individual and societal risk measures;
- to plan for routes modifications and/or improvements of infrastructures.

The Project is coordinated by a University Department which collaborates with local administrations above all in the first phase of data collection.

Difficulties arose immediately in identify origin and destination of transported substances, because the Region is passed by fluxes from/to Nord of Italy (see figure where Italy and the location on it of the Region Emilia-Romagna are present). Important is the traffic of fuels like gasoline, gasoil. Significant, and more dangerous, is the transport of LPG too. This substance has been involved in three incidents occurred in the neighbourhood of Bologna (the regional capital) in few months: one without spill, one with spill without ignition and the last a spill with a jetfire without damages to human beings, because it happened during the night in a highway far from houses.

The collection of flows requests first of all the collaboration of the companies whose activities are covered by Seveso law, because they use dangerous substances as raw materials or intermediates, but also of transport companies to have details on routes used by drivers.

This phase, which is crucial for the success of the Project activities, is now in progress.

HazMat transportation on rail: a national experience

On 2002 RFI (Rete Ferroviaria Italiana), the manager of the railways system, commissioned to some University Departments (of Bologna, Roma La Sapienza and Milano) a study whose main contents are well summarized by the title of the Congress organized to present Project results: “Forecast, prevention and management of risks to improve HazMat transport safety”.

The analyses have been focused on:

- magnitude and importance of risks due to HazMat trains travelling on Italian territory;
- complexity and relevance of Italian regulation on the matter;
- validity of current system of operation rules and procedures for managing emergencies.

Main aims were the activation, if necessary, of technical, managerial and procedural measures and the updating of the informative system.

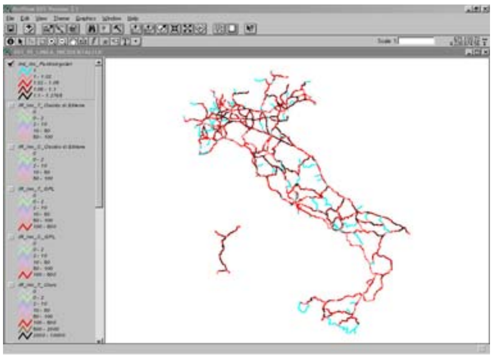
This study, based on a quantitative approach to risks, considers the Italian rail network, represented in figure, and some marshalling yards where large amount of hazardous substances were and are transported. The attention has been focused on five substances: gasoline, LPG, chlorine, ammonia and ethylene oxide, which well represent substances of large diffusion on Italian territory and are characterized by flammable and toxicity hazards. Some paragraphs of the Project deserve mention even if the study can not be completely summarized owing to its wideness.

The starting point has been data collection on amounts of substances transported: the network transports in all 3.2×10^6 t of dangerous goods, a total of about 75 000 wagons, and the considered substances are about 50% of the global traffic. It is worth noting that the chlorine transport - but the consideration is true for other substances too - is strictly related to the fate of chemical establishments present on the Italian territory and subjected to Seveso regulation.

The whole network has been conveniently represented on a GIS structure where layers have been introduced to locate specific points (bridges, galleries…), hazardous chemical plants and population density (up to 5 km from the railway). The risk quantification has been done in two steps: in the first phase partial indexes have been built to describe danger of substances, network critical points and meteorological conditions and a global index has

[1] Analysis of the Industry and Port Risks of the Ravenna Area

been obtained which describes the risk associated to each line of the railway; in the second phase a proper QRA has been executed to detail risk to which population is exposed with the calculation of quantitative measures (local, individual and societal risk). In this last phase the attention has been focused on some marshalling yards, town crossings and galleries in order to put in evidence criticalities, if present.



A special care has been devoted to the planning, the management and the monitoring of transport: a prototype of information system has been arranged, one of the aims being the allocation of tracks to dangerous goods through a procedure of risk minimization. The problem of monitoring wagons has been deepened too, by examining physical parameters to be measured, sensors able to give reliable values, transmission devices and costs of the feasible solutions.

The whole Project was completed at the beginning of 2004 and its results presented to Italian public authorities, local administrations and sector operators at the end of November 2004.

FEATURES

Lessons learned from real world

Sheryl Hurst

Steve Lewis

Risk assessment lies at the heart of risk management and one of the most powerful and increasingly popular risk assessment techniques is the bow-tie method. Its strength is that it goes beyond the usual risk assessment 'snapshot' and highlights the links between risk controls and the management system. It is an excellent demonstration tool, but is also well suited to communicating risk issues to non-specialists.

Bow-ties originated as a method for assessing hazard and operational risks. Undoubtedly, the Royal Dutch/Shell Group was the first major company to integrate fully the total bow-tie method into its business practices and is credited with developing the technique which is widely used today. Use of bow-ties has subsequently spread between companies, industries, countries and from industry to regulator, and their application has extended across all risks (e.g. financial, strategic, security, quality, business interruption, political, human resources, design, project risk).

Bow-tie Method

The method for building a bow-tie diagram is well-documented, and involves asking a structured set of questions in a logical sequence to build up the diagram step by step (Figure 1). The completed bow-tie illustrates the hazard, its causes and consequences, and the controls to minimise the risk. Facilitated workshops involving people who are regularly confronted with the hazards have proven to be the most effective way of identifying real controls and capturing current practice.

Practical Uses and Benefits

Demonstration – Bow-ties are used to demonstrate that hazards are being controlled, and that there is a direct link between the controls and elements of the management system. For example, bow-ties have been used successfully in safety reports produced for compliance with the UK onshore chemical industry Control of Major Accident Hazard (COMAH) Regulations.

There are other ways of demonstrating this link (e.g. tables) but the bow-tie provides the clearest graphical illustration which is so easy to understand.

Application of the Bow-tie Method

Tips for Success…

- **Involve people**. Operational experience or bow-tie experience alone gives sub-standard results; a combination of the two is essential.
- **Pitch at the correct level of detail**. Too high and the bow-tie is meaningless. Too low and the exercise is labour intensive. Controls should be independent and self-explanatory. Tasks need to be meaningful and assigned at a level where their completion can be verified.
- **Keep the end objective in mind**. Prioritise effort on risks which are of greatest concern. For operating facilities focus on operational controls not re-assessing the quality of an earlier design process.
- **Demonstrate risks are reduced to As Low As Reasonably Practicable**. Ask "practically, what extra controls can we add?". Avoid barrier counting where possible.

▪ **Don't get hung up on software**. The benefits from the bow-tie process are largely independent of the means by which the bow-tie is constructed.

▪ **Use the method to its full potential**. The bow-tie is only part of the picture; critical tasks provide the link between controls and the procedures and people responsible for ensuring they will continue to be effective.

▪ **Verify controls and tasks**. A follow up audit/inspection helps to ensure the credibility of the bow-tie and the completeness of the management arrangements.

Communication – The diagram is understood by personnel at all levels of an organisation, including those who are not connected with the day-to-day operation being assessed. The bow-tie can be displayed on posters highlighting key risk control issues. Pocket books and leaflets have also been produced for dissemination of the risk management message, and web-based bow-ties form part of on-line training and information systems. The graphical-based approach is easy to implement with multi-national teams.

It is not necessary to use sophisticated techniques to get the most from the bow-tie method. Talking through the components of a particular scenario whilst sketching a bow-tie layer by layer can clearly illustrate how the hazard is managed.

Organisational improvements – Bow-ties can highlight areas where organisational control is weak, enabling proactive, sustainable strategies for reducing risk to be focused on these areas. Bow-ties have also been used to ensure that no critical controls 'fall through the cracks' after a company re-organisation. Bow-ties can be used during incident investigations to identify organisational weaknesses that allowed risk controls to fail.

Procedures and competence – A completed bow-tie analysis includes a list of critical tasks undertaken to ensure ongoing integrity of risk controls. The tasks can be used to verify the adequacy of a company's competence assurance system; the competencies defined for each role should align with the bow-tie controls. Bow-ties have also been used to manage handover/new-starter responsibilities.

Critical systems – Systems which prevent, detect, control or mitigate a hazardous event are deemed 'critical'. Such systems are clearly illustrated along the threat and consequence branches of the bow-tie and can be linked to defined performance standards and means of verification.

'Future proof' risk management – Unlike other risk assessment techniques, the bow-tie illustrates not only what controls are currently in place, but, through the use of critical tasks, why they will still be there tomorrow.

Ownership – Bow-tie workshops stimulate communication between key stakeholders who all have a role to play in managing risk. Bow-ties focus on risk management at the operational level for use by operational people, rather than technical risk specialists. All staff can see why what they do is critical for risk control.

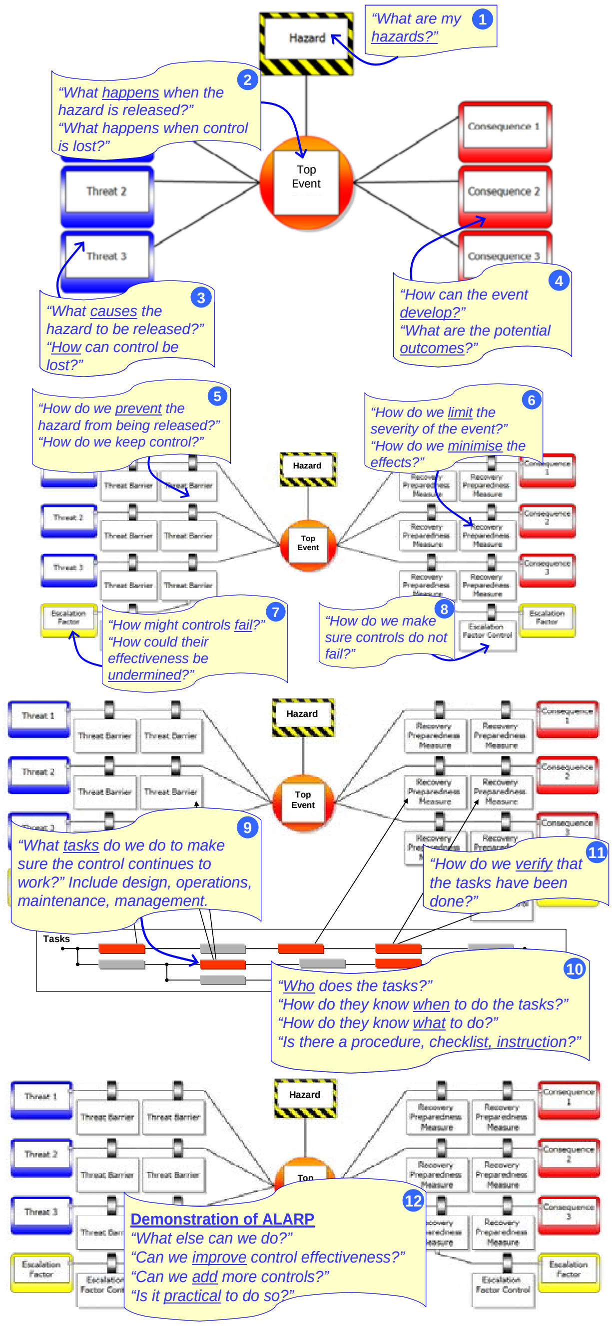


Figure 1 - Building the Bow-tie

Bow-ties provide a clear visualisation of the relationships between the causes of business upsets, escalation to a range of possible outcomes, and controls which prevent the event from occurring and limit the consequences. More importantly, the controls are linked to tasks, procedures, responsible individuals and competencies, thereby identifying how the management system provides assurance that risks will continue to be properly managed.

Auditable trail – Bow-tie diagrams and critical task lists provide a protocol for auditing management arrangements.

Conclusions

The benefits of using bow-tie diagrams for risk management have been realised by organisations world-wide across a variety of business sectors. This paper draws on more than fifty person-years of experience in applying the bow-tie method.

Case Study

In one oil and gas industry case, where onshore wells are periodically drilled close to third party land, the operating company has pioneered the use of bow-ties to illustrate to the regulator and members of the public that the hazards associated with the operation are recognised, understood and well managed, both from a preventive point of view and for preparedness in the event of an emergency. Simply drawing bow-ties freehand during public meetings helped considerably in putting across the message that the company was in control of the hazards and the risks were minimised.

Universal Reliability and Availability Modelling (URAM)

by Jeff Jones,
University of Warwick &
Les Warrington,
Research in Motion

Maintenance of complex assets is not always simply a reactive task of responding to equipment failures and routinely scheduling preventive maintenance. Rather, operational tasking may require maintenance to be deferred, and use of prognostics may allow discretionary anticipation of equipment replacement. Nor is complex system design simply a case of increasing component reliability and incorporating greater system redundancy.

The concept of Maintenance Free Operating Periods (MFOP) originated as a series of fixed operational periods, each followed by a Maintenance Recovery Phase (MRP). However, it might more universally be viewed as a co-ordination of failure avoidance, failure anticipation and maintenance delay techniques, with the objective of enhancing operational capability in a cost-effective manner.

Fulfilment of an optimal MFOP requires co-ordination of system design, in-service maintenance and operational scenario. Individual aspects might be modelled mathematically but discrete event simulation is required for a complete analysis.

MFOP is, as its name suggests, an extended period of operation free of maintenance requirements. Early representation of the concept used a repetitive sequence of MFOP, each followed by an MRP, but this has since been extended to include other sequences. However, a generalised concept is one MFOP-windows, characterised by failure avoidance, failure anticipation and maintenance delay, illustrated by Figure 1. (The UK MoD definition of MFOP allows for some minor maintenance during the operational period.)

Assured achievement of a defined MFOP will particularly require careful forward planning of maintenance activity, to ensure co-ordination with operational tasking. Significantly, maintenance should not be entirely reactive but should include scheduled equipment replacements and use of prognostics. A system design, optimised for MFOP achievement, will combine high component reliability, robust systems, prognostic information and well targeted scheduled replacement lives. The design challenge is to achieve the optimal combination of these features, suited to particular operational scenario. Previous papers examining MFOP potential have quite rightly highlighted the potential cost of achieving high values of MFOP, or have concentrated on individual methodologies of achievement and have quite rightly identified limitations of each. However, research is ongoing to investigate holistic application, pointing out developing support technologies and URAM is an important part of this research.

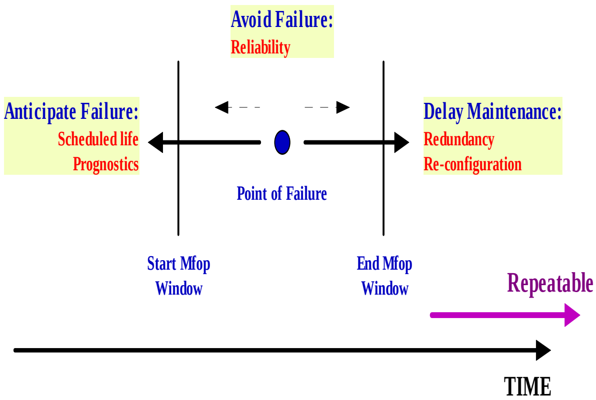


Figure 1: Moving potential failures outside the MFOP

The maintenance challenge is to manage the anticipation and delay of maintenance to gain maximum advantage from the design, whilst minimising cost and mission critical failure during the MFOP window.

Universal Reliability and Availability Model

Discrete event simulation when applied to R&M, models individual R&M processes and links them to events generated by operational processes. Thus, a component failure model will respond to an operation-process and lead to a failure event. The failure event will then trigger a maintenance process, together with subsidiary events such as equipment replacement and spares consumption. Success of further operational events will be dependent on the timely success of the maintenance process.

Universal Reliability and Availability Model (URAM) is a highly user configurable discrete event simulation of system operation and maintenance. User-definition of an system is built up from template system definitions, incorporating multiple reliability models and complex redundancy. Maintenance capabilities are defined for each operating location, with scheduling plans dynamically altering objectives and resources. Maintenance is a set of managed technical activities whose objective is to retain or return a system's performance. Definition of a system may be as simple as single equipment or it may be a complex network with multiple demands. A fleet of aircraft, operating an airline's route schedule and being supported by several airport maintenance depots, is an example of a complex network.

Maintenance of systems is both a managerial and a technical challenge. Management challenges include:

Identification of Objectives

Maintenance activity does not necessarily continue until all system malfunctions are corrected. Rather, there will often be a trade-off between operational tasking, and the cost and time involved in continued maintenance. Maintenance management should seek the optimum trade-off. However, this trade-off is dynamic, dependent on overall circumstance. For example, an system undergoing over-night maintenance would probably be returned to operation, to meet its morning schedule, notwithstanding that certain non-essential faults are outstanding. Similarly, if a replacement spare is not available, a system will often remain in operational service pending re-supply. It is there proposed that an operation-maintenance trade-off process is one of 'over-ride' of an existing objective with another, namely either:

Operation has first priority, unless over-ridden by specific maintenance requirements, or

Maintenance has first priority, unless over-ridden by other specific requirements

The important aspect for a discrete event simulation, therefore, is to identify dynamically the conditions under which the basic process should be over-ridden.

Mission Planning

URAM has implemented scenario plans that identify specific system capability requirements. Each system capability is compared against this plan and allocated accordingly. The allocation is updated whenever an system become available or gains additional capability through maintenance recovery. If this new system offers greater capability for a given scenario, then the existing allocation is released and re-allocated, in order to maximise overall allocation.

Prognostics & Scheduled Maintenance Anticipation

Prognostics are the facility to identify impending system malfunction concurrently with being able to provide a reasonable prediction of the timing of that failure. Provided a technician is made aware of such outputs, appropriate maintenance action may be initiated.

Analysis of current prognostic technology indicates that timely maintenance intervention is not assured and currently appears to prevent application to safety critical systems. Firstly, there is a finite likelihood that a technician or in-built system would detect a prognostic indicator. Secondly, it would be necessary to convert the prognostic indicator to a predicted time to failure, before which there is adequate time to initiate maintenance. This predicted time to failure is not simply a prediction of physical failure, but would also be a reflection of the hazard posed by such failure. For example, a safety hazard would impose a prediction before which there would be little or no risk of actual failure. A lesser hazard would allow a higher risk of actual failure before maintenance action.

URAM implementation of prognostic models define a maximum look-ahead (horizon before which a prognostic indicator will never be detected, delay time, or P-F interval), permissible risk of using prognostic information yet allowing failure before replacement, and maximum likelihood of a technician or in-built system identifying the prognostic information.

URAM also allows specific anticipation of scheduled equipment replacements. This may be planned on a regular basis and co-ordinated with tasking. Scheduled maintenance anticipation could, for example, be just ahead of operational deployment of an system.

Cost Rules

Within URAM, each LRI also has a user-assigned cost & repair time, to allow use of extended task prioritisation plans. The structural importance is factored by the cost and/or time to reflect specific prioritisation objectives.

Conclusion

The approach described offers a coherent approach to discrete event simulation modelling of maintenance. It covers both managerial and technical aspects of maintenance. It provides clear links to operational tasking, relates system design to maintenance execution, is in harmony with a natural maintenance process, and is not limited to any one particular situation.

URAM has been developed initially in support of aircraft reliability and maintenance research.

However, through use of universal concepts, it would be easily modifiable to any complex system

Acknowledgement

URAM was developed under sponsorship of the UK Defence Evaluation & Research Agency (DERA) and with the support of BAE Systems, GKN Westlands, Rolls Royce, Messier Dowty, City University & The Royal Air Force.

CALENDAR OF SAFETY AND RELIABILITY EVENTS

EURODYN 2005 – 6th European Conference on Structural Dynamics

4th-7th September, 2005

Paris, France

Conference Website:
http://www.eurodyn2005.univ-mlv.fr

PSAM 8 - International Conference on Probabilistic Safety Assessment and Management

14th-19th May, 2006

New Orleans, Louisiana, USA

Conference Website:
http://www.psam8.org/index.html

OMAE 2006 – Safety and Reliability Symposium

4th-9th June, 2006

Hamburg, Germany

Hamburg is the host of OMAE-2006. Following on the tradition of excellence of previous OMAE conferences, OMAE-2006 will be held to advance the development and exchange of information regarding ocean, offshore and arctic engineering. It will be the ideal forum for researches, engineers, managers, technicians, and students, to discuss new and advanced technology developments and their applications in industry. It will also help promote international cooperation.

More than 400 technical papers are expected to be presented at the conference distributed in various symposia, one of which is:

- Safety and Reliability

Also, industry workshops, special sessions and keynote lectures will be included in the technical program. National and international companies are expected to sponsor and participate in the conference.

Conference Website:
http://www.ooae.org/omae/omae2006/omae2006.htm

Third International ASRANet Colloquium Integrating Structural Analysis, Risk and Reliability

10th-12nd July 2006 - Glasgow, UK

Following the success of the second ASRANet International Colloquium held in Barcelona, Spain in July 2004, which attracted around 70 delegates from 17 countries around the world, the Organising Committee now invites papers from researchers and practitioners in Structural Analysis, Risk and Reliability for the third Colloquium, to be held in Glasgow on 10-12 July 2006.

Conference Website:
http://www.asranet.com

ESREL 2006 – The European Safety and Reliability Conference

18th – 22nd September, 2006

Estoril, Portugal

The purpose of the conference is to present and discuss innovative as well as traditional methods and applications for improving the design and operation of products, processes, equipment and installations from a safety point of view, while taking into account also the realistic constraints on the available physical and economical resources. Consideration is also given to the societal factors influencing the use of risk assessment and risk management methods. Safety and Reliability Workshops will also be organized to provide additional forums for an open exchange of ideas.

Authors are encouraged to submit an abstracts directly to the ESREL 2006 Conference Secretariat or through the dedicated webpage. The abstract should be divided into three separate sections presenting context, innovative aspects and results of the proposed paper.

The abstracts will be accepted after a reviewing process performed by the members of the Conference Technical Program Committee. The template and an exemplary abstract are given at Conference Website.

Conference Website:
http://www.esrel2006.com/

ESRA INFORMATION

1 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
- ESReDA
- French Institute for Mastering Risk, France (IMdR-SdF)
- ESRA Germany
- The Norwegian Risk and Reliability Association (ESRA Norway)
- SRE Scandinavia
- The Netherlands Society for Risk Analysis and Reliability (NVRB)
- Polish Safety & Reliability Association, Poland
- Asociación Española para la Calidad, Spain

1.3 Companies

- TAMROCK Voest Alpine, Austria
- ARC Seibersdorf Research GmbH, Austria
- VTT Industrial Systems, Finland
- Bureau Veritas, France
- INRS, France
- Total, France
- Commissariat á l'Energie Atomique, France
- GRS, Germany
- VEIKI Institute for Electric Power Research Co., Hungary
- Autostrade, S.p.A, Italy
- D'Appolonia, S.p.A, Italy
- IB Informatica, Italy
- TECSA, SpA, Italy
- SINTEF Industrial Management, Norway
- Adubos de Portugal, Portugal
- Central Mining Institute, Poland
- Transgás - Gás Natural, Portugal
- Companhia Portuguesa de Producção Electrica, Portugal
- Siemens SA Power, Portugal
- Caminhos de Ferro Portugueses, Portugal
- ESM Research Institute Safety & Human Factors, Spain
- IDEKO Technology Centre, Spain
- TNO Defence Research, The Netherlands
- HSE - Health & Safety Executive, UK
- Railway Safety, UK
- W.S. Atkins, UK

1.4 Educational and Research Institutions

- University of Innsbruck, Austria
- Université Libre de Bruxelles, Belgium
- University of Mining and Geology, Bulgaria
- Technical University of Ostrava, Czech Republic
- Technical University of Liberec, Czech Republic
- Tallin Technical University, Estonia
- École de Mines de Nantes, France
- Faculté de Polytechnique de Mons, France
- Henri Poincaré University, France
- ISI, France
- LAAS, France
- Université de Bordeaux, France
- Université de Technologie de Troyes, France
- Université de Marne-la-Vallée, France
- Technische Universität Muenchen, Germany
- Technische Universität Wuppertal, Germany
- National Centre for Scientific Research 'Demokritos', Greece
- DICMA, Italy
- Politecnico di Milano, Italy
- University of Rome "La Sapiensa", Italy
- Universita Degli Studi di Pavia, Italy
- Universita Degli Studi di Pisa, Italy
- Technical University of Delft, The Netherlands
- NTNU, Norway
- University of Stavanger, Norway
- Gdansk University, Poland
- Gdynia Maritime Academy, Poland
- Institute of Fundamental Technological 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
- Institute "Jozef Stefan", Slovenia
- Universidad D. Carlos III de Madrid, Spain
- Universidad de Cantabria, Spain
- Universidad de Las Palmas de Gran Canaria, Spain
- Universidad Politecnica de Madrid, Spain
- Universidad Politecnica de Valencia, Spain
- Consejo Superior de Investigaciones Científicas, IMAFF, Spain
- Lulea University, Sweden
- City University London, UK
- Liverpool John Moores University, UK
- University of Bradford, UK
- University of Portsmouth, UK
- University of Salford, UK

1.5 Associate Members

- Nuclear Consultants International, South Africa
- Fulminese Federal University, Brazil
- Universidad Central de Venezuela, Venezuela

2 ESRA Officers

Chairman
Carlos Guedes Soares (guedess@alfa.ist.utl.pt)
IST, Technical University of Lisbon, Portugal

Vice-Chairman
Enrico Zio (enrico.zio@polimi.it)
Dept. of Nuclear Eng. Polytechnic of Milan, Italy

General Secretary & Treasurer
Pieter van Gelder (P.van.Gelder@ct.tudelft.nl)
Delft University of Technology, The Netherlands

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.

3.1 Conference Standing Committee

This committee aims at establishing the general policy and format for the ESREL Conferences, building on the experience of past conferences, and to support the preparation of ongoing conferences. The members are one leading organiser in each of the ESREL Conferences.

3.2 Publications Standing Committee

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

4 Technical Committees

Technological Sectors

4.1.1 Offshore Safety

Chairman: B. Leira, NTNU, Norway
E-mail: Bernt.Leira@marin.ntnu.no

4.1.2 Safety of Maritime Transportation

Chairman: C. Guedes Soares, IST, Portugal
E-mail: guedess@alfa.ist.utl.pt

4.1.3 Safety of Land Transportation

Chairman: Gigliola Spadoni, Univ. of Bologna, Italy
E-mail: gigliola.padoni@mail.ing.unibo.it

4.1.4 Safety in Civil Engineering

Chairman: Ton Vrouwenvelder, TNO Bouw, The Netherlands
Email: A.Vrouwenvelder@bouw.tno.nl

4.1.5 Safety in the Chemical Industry

Chairman: I. Papazoglou, Demokritos Inst. Greece
Email: yannisp@ipta.demokritos.gr

4.1.6 Safety from Natural Hazards Methodologies

Chairman: J.K. Vrijling, Technical Univ. of Delft, The Netherlands
Email: J.K. Vrijling@ct.tudelf.nl

4.1.7 Reliability of Mechanical Components

Chairman: G.I. Schuëller, Univ. of Innsbruck, Austria
E-mail: G.I.Schueller@uibk.ac.at

4.1.8 Uncertainty and Sensitivity Analysis

Chairman: A. Saltelli, JRC, ISPRA, Italy
E-mail: andrea.saltelli@jrc.it

4.1.9 Human Factors

Chairman: E. Fadier, INRS, France
E-mail: fadier@inrs.fr

4.1.10 Stochastic Modeling and Simulation Techniques

Chairman: Pierre E. Labeau, Université Libre de Bruxelles, Belgium
E-mail: pelabeau@ulb.ac.be

4.1.11 Maintenance Modelling and Applications

Chairman: Enrico Zio, Politechnic of Milan, Italy
Email: enrico.zio@polimi.it

4.1.12 Safety Management

Chairman: A.R. Hale, Technical Univ. of Delft, The Netherlands
Email: a.r.hale@tbm.tudelft.no

4.1.13 Accident and Incident Modelling

Chairman: Chris Johnson, Univ. of Glasgow, UK
Email: Johnson@dcs.gla.ac.uk

4.1.14 Occupational Safety

Chairman: Lars-Harms Ringdhal, Royal Institute of Technology, Sweden
Email: Lars_Harms-Ringdhal@lector.kth.se

4.1.15 Quantitative Risk Assessment

Chairman: V. Trbojevic, Risk Support, UK