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GUEST EDITORIAL

The papers collected in this issue[1] are extended versions of selected works presented at the European Safety and Reliability Conference, ESREL 2001, held in Torino, Italy, on 16–20 September 2001. This Conference is organized annually under the auspices of ESRA, the non-profit European Safety and Reliability Association, with the aim of promoting an exchange of different experiences in the field of safety and reliability and disseminating the safety culture.

The programme of the Conference included specialists presentations of innovative, as well as standard, 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. Although much emphasis was given to the safety and performance requirements, including life cycle processes and cost analysis, of modern engineering systems subject to natural and man-made hazards, significant consideration was given also to the non-negligible societal factors influencing the use of risk assessment and risk management methods. Integral demonstrations of the use of risk analysis and safety assessment were provided in many practical applications concerning major technological systems, ranging from chemical and nuclear ones, to aviation and aerospace ones, to road and railway transport ones, to civil and structural ones, and more.

Among the many good papers presented at the Conference we chose a handful depicting three key aspects of the modern view of safety: the increasing need for risk-based, risk-informed optimization of production and management activities [1–3]; the effects of human and organizational factors on risk assessment and control [4–6]; the influence of risk perception and attitude on the acceptance of design and management solutions [7–9].

To give a taste of the research in the field of risk-based, risk-informed optimization we chose an heterogeneous set of approaches to an homogeneous field of application, that of transport safety. The sorrowful latest accidents have confirmed that transportation activities, of various types and nature, represent a not negligible source of individual and social risk. The need for a proper management of such activities in order to reduce the hazard is evident and new provisions, mainly focused on road, rail and air transportation, are continuously discussed at the operational and regulatory levels.

In this respect, the paper by Cooper [1] recognizes the complexity of modern transportation systems and the corresponding need to develop effective risk management decision tools to help rank alternatives, allocate resources, and certify critical transportation operations. Existing methods often fail to accommodate the dynamics of changing environments and threats, in the presence of uncertainty and vagueness and with the 'soft' data often available for the analysis. The paper

[1] A small number will appear in subsequent issues this year. Ed.

discusses a coordinated set of ongoing model-development efforts to overcome such difficulties. These efforts rely on a proper system description in terms of a double first-level decomposition (risk-based and functional) to identify the potential safety problems and the important decision-drivers. This first-level decomposition undergoes a further decomposition in sub-modules which provide the analytical basis for an hybrid aggregation of the derived risk and performance metrics. Two specific types of analyses are particularly interesting for aggregating the identified metrics: (1) a risk-based analysis that follows the risk decomposition structure for analytical aggregation, and (2) a requirements-based analysis that follows the functional decomposition for analytical aggregation.

Within the problem of managing transportation risk, the contribution by Mazzarotta [2] considers the opportunity of switching from road to rail or to a combination of road and rail (intermodal) transport with the objective of achieving significant risk reduction in the transport of dangerous goods. The potential for risk reduction mainly arises from the consideration that rail accident rates are usually much lower than road ones. However, risk reduction is not straightforward. In fact, the use of rail generally implies that larger amounts of product are transported (and potentially released) per trip and/or that more population is present along the route. Similarly, the use of intermodal transport exposes the container to the additional risk of being damaged each time it is moved. Most discussion in the field concerns the classes of goods to be moved from road to rail, and the absolute and/or relative length of road and rail routes to be exceeded for switching from one transport modality to the other. The work by Mazzarotta presents a quantitative framework, based on risk analysis, for comparing the hazards of road, rail and intermodal transport. When comparing road and rail transport, the risk mainly depends on the hazardous characteristics of the product, since the size of the containers, and consequently the amount of product potentially released, is generally larger for rail than for road transport giving rise to impact areas slightly or significantly larger than the corresponding road ones, depending on the substance. When comparing road and intermodal transport, route length plays the most significant role: the longer the distance, the safer the intermodal transport.

The last paper of this triplet, by Eisinger and Zio, looks at the problem of air transportation services and activities from a somewhat different perspective, that of logistics, which greatly influence the design and management choices. The modeling of the airport logistics is commonly treated by collecting key data on airport operation and combining them with empirical formulas, to provide estimates on the performance of the airport. Such an approach has been found to work well as long as the required level of detail to be captured in the formulas is low and the airport resources utilization is low. With increasing utilization, the interaction between resources increases significantly, causing sensible effects (for example, nonlinearities) on the involved quantities. In these cases, detailed modeling is required and one has to resort to the Monte Carlo simulation approach which lends enough flexibility to model the actual logistic system to the desired level of realism and accuracy. Then, to introduce improvements in the airport system performance, one usually carries out extensive what-if analyses which amount to changing the key system parameters and then re-evaluating the performance of the system by simulation, to check whether it has improved or not. This what-if approach is often tedious and finding

the optimal solution can sometimes be a matter of chance due to two main complications: the large size of the input parameter space within which the design choice is to be made (several hundreds or thousands of possible parameter settings and alternative design options) and the lack of an explicit mathematical expression of the performance function for the optimization. To overcome these difficulties, an approach is proposed which combines the Monte Carlo engine for performance evaluation to a genetic algorithms' engine for the search of the optima airport logistics. The coupling of genetic algorithms optimization techniques with Monte Carlo simulation is shown to provide a powerful tool for the efficient design and operation of real industrial systems.

Nowadays it is well recognized that the technical risk assessment of any modern industrial system cannot avoid facing the complex interlacements deriving from the organization–man–machine interactions. The analysis of major accidents and their catastrophic consequences (for example, Three Mile Island, Chernobyl, Bhopal, Challenger, Piper Alpha, etc.) corroborates the fact that they are partly attributable to hardware failures and associated flaws in the design of the safety and protection systems, to operators' errors, and to inadequacies in the organization of the accident management. The appropriate modeling and accounting of the effects that organizational factors and human behaviors have on the safe operation of engineered systems have, thus, become a central issue in current research in the area of safety and risk analysis. In this context, the paper by Kosmowski and Kwiesielewicz [4] presents a conceptual framework for the systematic incorporation of human and organizational factors in probabilistic models for risk assessment and management. The methodology inherits qualitative procedures and quantitative techniques typical of the human reliability analysis and applies them in the context of a Probabilistic Safety Assessment. The multiattribute decision problem is decomposed using a hierarchical influence diagram mutuated from the analytic hierarchy process decision-making tool. The possibility of treating partly qualitative (soft) and partly quantitative (hard) data is handled with a fuzzy extension of the approach.

The ultimate decision based on risk analysis requires the definition of appropriate risk acceptance criteria. The paper by Skjong and Eknes [5] tackles this issue and outlines an approach by which risk acceptance criteria may be established. In general, societal risk acceptance criteria, and the societies' risk aversion against large or catastrophic accidents, are lacking an explicit rationale. Some people would count the risk aversion against large accidents as one of the 'risk conversion factors' representing the bias 'perceived risk' as compared to 'actual risk'. Although their rationality may be debated, criteria explicitly including severity are used by a large and increasing number of regulators. In this context, the objective of the method proposed by the authors is to establish transparent risk acceptance criteria with a rational foundation, which may be established from factual and available information. The underlying idea is that any acceptance criterion should discriminate between activities representing different risks and importance to society. Obviously, many other criteria would be needed in the decision process, such as individual risks, criteria based on cost effectiveness, and criteria for environmental consequences. In any case, the examples provided in the paper show that the fact of including in the analysis the importance to the society may lead to risk acceptance curves which vary by 1 or 2 orders of magnitude.

Sociological aspects affect also the evolution of accident emergency responses and must be accounted for in the a priori analysis and design of emergency plans. This is the subject of the paper by Mazzini, Contini, and Volta [6] in which a methodology for external emergency planning and analysis is presented which aims at taking into account not only the physical phenomena, but also the sociological aspects involved in accident emergencies. The methodology has been implemented into two software tools which allow to efficiently simulate various accident scenarios and population behaviour during the evacuation, thus providing a tool for evaluating and comparing different emergency plans. This type of tool can be of significant value to alleviate the main concerns of the public authorities in respect of the social dimensions of the emergencies and the complexity arising from the interaction among physical, technical and organizational factors.

It is well known that, independent of the response of accurate technical risk assessments, other important social and sociological factors, such as risk perception and attitude, can greatly influence the risk management of modern activities. Within this realm, the first paper by Harvey, Erdos, Bolam, and Gregory [7] compares safety attitudes and beliefs of workers in four departments of a nuclear power plant. This study was conducted within a highly regulated organization, which clearly and necessarily has safety at the forefront of its agenda. Six safety culture factors where found to apply to all employees in this organization and a further two which seem to be identified only with management. Most studies agree on several attitude areas in safety culture, such as satisfaction, leadership style, and communication, as well as risk taking and awareness, responsibility, and commitment, which are also apparent in some other studies. This study has, however, identified a factor, which is not apparent elsewhere. Indeed, this study has found that most individuals have a high level of perceived responsibility for safety but has also shown that there are several areas of discontent, mainly amongst shop floor employees, in terms of avoidance or alienation. These areas mostly concern communication and management style. If these areas are viewed as organizational 'latent failures' then individual accidents or 'active errors' will continue to occur until the latent failures are resolved and this may translate into negative public opinion, which confirms that safety issues in the nuclear industry have a relevance beyond the industry itself. Overall, the result of the study was to point out that there are two or more parallel safety cultures in the organization. This situation may be common to other similarly structured organizations. Indeed, it is proposed that the belief systems themselves differ in fundamental ways for different groups of employees. In any organization, as a hierarchy is created, employees acquire different experiences and beliefs that reflect their activities, work group and level or grade; inherently, therefore, different cultures develop. The existence of different cultures does not automatically imply one negative and the other positive: more than one culture should be acceptable and even expected in any organization, and the efforts should be devoted towards making the best of such a situation rather than trying to change it. From the safety policy viewpoint, the implications are that it must be recognized that many organizations may contain several safety cultures and that each need to be understood and developed for the best. In the nuclear industry, where the public, the government, and the regulatory agencies are all stakeholders, safety policies should be the result of

teamwork embracing the perspectives of the different cultures involved, each contributing their valid and sometimes differing views on safety.

The peculiarity of the safety issues in the area of nuclear technology is also the subject of the paper by Gromann de A. Goes and Malburg da Silveira [8] who describe the World dynamic scenery that has developed through the years and discuss the role of Brazil. The authors strongly lament the high degree of ignorance on fundamental concepts such as safety and risk and the implication that this situation has on the politics of technological development. The need for a proper 'environmental education' is highlighted together with the imperative that public opinion and perception of the risk associated with nuclear facilities be carefully considered within the social debate among all the involved stakeholders, that is, the legislators, the operators, and the public.

Risk perception and attitude are key factors in all highly publicized risky activities. This is witnessed in the empirical study of the public attitudes towards genetically modified food by Harvey, Erdos, Holme, Raven, Staunton, Walton *et al*. [9]. The study investigates the relationship between consumption of proteins and attitudes towards genetically modified foods as a result of a survey on 600 shoppers in a city centre supermarket in the United Kingdom. In addition, various demographic variables were measured among which gender was the best predictor of consumption and attitudes (men and women are very different in their attitudes and behaviour in relation to many foods and associated perceived threats), followed by socioeconomic status and age. Attitudes were found to correlate positively with consumption of several proteins. The authors provide substantial explanations of these relationships in terms of the theories of reasoned action, cognitive dissonance and attribution and the health belief model. In terms of policy, the results of this research suggest that the Government of the United Kingdom is unlikely in the near or medium future to be able to persuade consumers to change their minds about genetically modified foods. The impetus for change, currently in the direction of not accepting these types of foods, would seem to rest with the supermarkets and their responses to their own interpretation of the effects of attitudes and perceptions of consumers upon purchasing behaviour. It is suggested that the absence of clear evidence and apparent vested interests have affected consumer attitudes, perception of risk and behaviour, and in the case of the UK, this has probably been exacerbated by the effects of the earlier BSE crisis.

In concluding this editorial, I wish to thank the Editors of the Journal who have given me the opportunity to put together a collection of interesting works and all the contributing authors for their outstanding papers.