# European Safety and Reliability Association Newsletter

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## Editorial


*Terje Aven*
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*University of Stavanger, Norway*


Dear ESRA Colleagues,

It is a pleasure for me to address you in the opening of our newsletter. I wish you all a Happy New Year! The major event this year is the ESREL 2016 conference in Glasgow 25-29 September. See http://esrel2016.org. The conference is hosted at the Technology and Innovation Centre, a state of the art centre at Strathclyde University that is dedicated to industry-university collaboration. Together with ESRA, the University of Strathclyde and the UK Safety and Reliability Society – the professional body for Safety and Reliability Engineers – have come together to bring ESREL 2016 to Glasgow. I am confident that the conference will be informative, stimulating, challenging and enjoyable.

November 12, 2015, the ESRA Officers had a meeting in Stuttgart. Two topics need to be highlighted. Firstly, ESRA has made an agreement with EU-VRi (European Virtual Institute for Integrated Risk Management, http://www.eu-vri.eu) about a new web platform for ESRA. This represents a milestone for the organisation and I am enthusiastic about what is coming. We need some time to build the platform but the potential for a living website is now certainly there, a platform which can stimulate communication to and between members of ESRA. In some months, all ESRA members will be contacted to provide relevant input to this platform.

Secondly, we will start in 2016 a series of webinars on relevant topics within reliability, safety and risk. We have established an agreement with a professional company on the administrative support for the webinars, and we hope to present the first webinar in March or April.

We also this year provide direct financial support to several initiatives proposed by our members in response to our annual call for project proposals. These initiatives relate to activities ranging from a two-days expert workshop in April focusing on reliability and risk issues in the field of structural engineering organised by the Technical University of Ostrava, Czech Republic; to a workshop on reliability technologies within the international conference on digital technologies in Rzeszow Poland 5-7 July 2016; to the ALT'2016 in Troyes June 22-24 - the 6th international conference on Accelerated Life Testing and Degradation models; to a training course in November on advanced methods for reliability, availability, maintenance, diagnostics and prognostics of industrial equipment at the Politecnico di Milano, Italy; and to an international conference and an international summer school on RAMS topics in Poland (SSARS). Congratulations to all and good luck with the activities. We look forward to reading about these events in coming issues of the ESRA newsletter.

Looking back on 2015, I would like to use the opportunity to thank all of you who work for ESRA, being it in a chapter or a Technical Committee, or in relation to ESREL. Your contribution is important and is essential for the operation and development of our organisation.

Also this year we will carry out an update of the ESRA memberships, and related payments. I hope that you have already ticked off for paid membership fee for 2016.

Thanks,

Terje Aven
Chairman of ESRA

# Feature Articles

## Do new Findings in Science of History Influence Risk Analysis?

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On a regular basis, ESREL-, ICASP-, ICOSSAR- and IPW-conferences show the growing diversity of methods and applications for both, structural reliability analysis as well as safety and risk analysis. Today, the required software is easy accessible, sometimes even in the public-domain, computing capacity is cheap, methods are well-founded and students more frequently study this topic at universities.

However, the application in day to day engineering business is still limited and mainly related to large-scale infrastructure projects. In many cases, uncertainty remains to be dealt with by means of engineering judgment. There exist different reasons for the limited success, but unfortunately a further reason evolved due to progress in the science of history. This fact will be explained in detail.

Many civil engineering structures are designed for lifetimes of up to 100 years. Usually certain probabilistic based safety concepts are applied to fulfill the required safety measures, e.g. the safety index, probability of failure or various risk measures. The input for these calculations are either pure probability functions or some representative values based on probability functions. The determination of the probability functions relies on measured data, nowadays mainly digitally provided. Unfortunately, in most realist scenarios measured data cover only a short period, usually in the range of decades or if we are lucky, a century, and in some exceptional cases more than two centuries. Therefore in many fields we are keen to include proxy data from some historical events, increasingly given to us by the climatologic historians. There exit a variety of proxies: written documentation, biological proxies, geological proxies and others.

However, instead of gaining progress in the robustness of the statistical analysis, the inclusion of historical data using proxies sometimes weakens the statistical investigations. Therefore the reputation of this investigation type loses more and more ground. Some examples should support this conclusion empirically.

As some authors have investigated the floods of the Rhine in Basel, Switzerland, over a period of several centuries, they claim to have found a flooding gap over a large part of the 20th century. This period overlaps with the measured data time series. Therefore, looking at the scale of the measured data or at a scale of several hundred years yields to significant different conclusions. Another team of authors using proxies found a lack of high maximum wind speeds in the middle of the 20th century in central Switzerland when looking over the last one and half century. Since measured wind data covers rather short time periods, this conclusion again strongly influences our probabilistic calculations.

Furthermore climatological historians state that the summer of 1540 in central Europe was at least as hot as the summer of 2003. How hot it really was is still an open issue, since it is very tricky to compare the proxy data with measured extreme air temperatures. So we virtually have to create a maximum air temperature number, which again strongly influences the outcome of the statistics, leaving all climatological trends beside.

Even worse, sometimes the historical proxy data include flaws, which become only visible by detailed, meticulous work: thousands of documents have to be provided, read, confirmed and double-checked again. Nice examples of the difficulties arising were shown in the basis document for the new macro-seismic Swiss Earthquake catalogue including translation errors in historical documents or lack of historical knowledge by wrongly displacing earthquake locations.

We have to face the fact that some of the well-chosen load numbers we apply in safety and risk analysis are changing faster than expected, not even considering physical effects such as climate change, new phenomena and of course, leaving beside political decisions and economical developments yielding to rapid structural aging.

On one hand we not only rely on, we are even chained to measured and quantitative data in our business. On the other hand, this data is limited and includes flaws. The fast growing insights from historical research yields to continuously changing data, consequently changing results of the statistical investigations and finally to different safety parameters in terms of probabilities and risks respectively. Considering a projected lifetime of 50 or 100 years, this is not acceptable.

Therefore using simple safety factors, sometimes called safety margins, is experiencing a renaissance. This is one possible course of action. Alternatively, we show our customers that our methods have to be applied repeatedly to existing structures as it is already common for some industries (living PSA, risk cycle, life cycle engineering) and that we explicitly have to pinpoint the uncertainties and convince our partners that it in the long term run it is more appropriate to face the truth than to rely on substitute measures which veil the uncertainty.

# Reliability of power generation considering common cause failures

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**Introduction**

Liberalisation and deregulation of the electricity market led to changes among the previously monopoly electric-power industry, as it was separated to a market and a government-regulated part. The reconstructed electric-power industry requires various utilities for generation, transmission and distribution of the electrical power to the consumers.

The market-regulated part includes utilities for electrical-power generation, marketing and electricity trading, while the government-regulated part is responsible for proper power-system operation and control. Since the power-system operation characteristics generally do not correspond to the reconstructed electric-power sector, introduction of new ancillary services such as frequency and voltage control, scheduling and dispatch, loss compensation and load following was necessary. These services are coordinated by the transmission-system operator.

One of the main tasks of a power system is to supply all consumers with electrical power within defined reliability standards, including an uninterrupted power supply. Disturbances in power system can occur randomly at any time and may lead to power-system instability or even its collapse, where several consumers may be affected. The probability of disturbances can be minimized by proper power-system upgrades and expansions, by replacing or upgrading the existing equipment with a more reliable one, by providing an adequate diversity of the elements, by providing an adequate transmission capacity of the network, but nevertheless, the disturbances in the power system cannot be completely prevented. The reasons for this lies in the random occurrence of disturbances, the possible random peak loads in the system, the variable and uncertain power generation from the renewable energy sources, the delays in delivery, installation, replacement and maintenance of the equipment and in the unpredictable weather conditions.

One of the characteristics of a power system is its inability to efficiently accumulate the electrical energy. To achieve an uninterrupted power supply reaching a balance between the generation and the consumption of electricity is needed. To ensure energy balance, additional generation operating reserves above the expected demand load are required. The operating reserves can be utilized in case of load and generation mismatch, which enables the power system to deal with unexpected changes in load or generation. Achieving the system balance has become more difficult with the increasing number of renewable energy sources, as the generation of electrical power from most of these unconventional energy sources is intermittent by nature.

Operating reserves are most often ensured by an installed cold-capacity reserve, which is not considered as part of a reliability evaluation, by potential-energy storage facilities, by pumped-storage hydro-power plants, by de-loaded wind-power plants or they can be imported. Some transmission-system operators suggest that for each MW of installed power from renewable energy sources another MW of backup must be available. However, introducing such measures may lead to very high expenses, which may not justify the benefits of the high reliability. On the other hand, operating reserves can also be defined by reliability analyses.

**Method**

The work is focused on a development of an analysis of power generation reliability that will consider the impact of variable renewable energy sources in the observed power system for a reliable day-ahead operation. Additionally, common cause failures of several generating units are considered.

In the first part, a theoretical background is given: the probability and reliability theory, power-generation reliability analysis, short-term forecasts of the expected demand load and the expected power generation from the renewable energy sources, ensuring an adequate level of operating reserves in the observed power systems and probabilistic risk assessment, where the common cause failures are discussed. The discussed background is basis for working in fields of power-generation reliability analysis and assessment.

In the second part, a new method for ensuring a reliable power generation is presented. The new method is based on an already well-established method for assessing the power-generation reliability, i.e., the Loss of Load Expectation (LOLE). Firstly, the definition of the index LOLE is expanded by the implementation of common cause failures of several generating units.

The common cause failures are implemented using the Beta factor method, the Multiple Greek Letter method and the updated Multiple Greek Letter method. Additionally, an updated Multiple Greek Letter method is presented, which enables a more detailed definition of outage states of generating units, where several root causes and coupling mechanisms for one generating unit can be considered.

Secondly, the LOLE definition is improved by the implementation of the renewable energy sources, whose power generation is variable and uncertain. Their random failures due to mechanical errors and equipment malfunctions are also considered. The upgraded index LOLE is then used to evaluate the power-generation reliability in each hour of the following day separately, as the short-term forecasts of the power generation from the renewable energy sources are accurate only for a few hours or a day in advance. The obtained hourly values of index LOLE are then used to determine, what amount of additional operating reserve within every hour is required to satisfy the reliability criteria.

**Analysis and results**

The results of the application of the new method were tested on a standard power system, i.e., the simplified 39-bus system of New England, and on a real power system, i.e., the Slovenian power system. The results show that the larger the system balance is (i.e., the greater the expected demand load reduced by the power generation from the renewable energy sources), the lower the power-generation reliability is. Therefore, the power-generation reliability in every hour depends on the expected demand load within the hour and on the forecasted power generation from the renewable energy sources.

Uncertainty of the renewable power generation also has a major impact on the power-generation reliability. The larger the forecast error for the power generation from the renewable energy sources is, the higher the value of index LOLE is. The larger the share of installed renewable energy sources is, the greater the impact of uncertainty of their generation on the power-generation reliability is. This represents the negative aspect of incorporating the renewable energy sources in power systems, as we cannot influence and precisely forecast their generation and can therefore not absolutely rely on their generation. Due to the uncertain generation from the renewable energy sources it is very difficult to accurately determine the power-generation reliability, which may consequently have a major impact on the determination of the appropriate level of additional operating reserve for ensuring a reliable day-ahead power-system operation.

The results also confirm that common cause failures of generating units have a major contribution to risk. If it is assumed, that two generating units can share the same cause of failure, the obtained power-generation reliability decreases and consequently a larger amount of additional operating reserve is required to satisfy the reliability criteria. The more generating units that are susceptible to common cause failures, the higher that their installed powers and unavailabilities are and the higher share of all their failures that are represented by the common cause failures, the lower the power-generation reliability is. Consequently, more additional operating reserve is suggested to achieve the desired level of reliability. This suggests that common cause failures of generating units need to be considered within reliability analysis, as they have a large impact on the power-generation reliability and on the amount of the required additional operating reserve. More, if common cause failures are considered according to the new Multiple Greek Letter method, outage states of generating units can be more accurately defined and a more detailed insight into reliability analysis is enabled.

By application of the presented method a reliable short-term electrical power supply to all consumers can be ensured; especially in modern power systems, where a large share of renewable energy sources is being installed. Additionally, the method takes into account the impact of simultaneous failures of several generating units caused by a common cause, such as the lightning strike. Consequently, the outage states of generating units can be more accurately defined, which enables the transmission-system operator to identify the critical failures of the generating units and to propose adequate measures in order to minimize the impact of common cause failures and therefore to ensure a higher power-generation reliability. The new method combines the impact of the variable and uncertain power generation from the renewable energy sources and the impact of simultaneous failures of several generating units caused by a common cause on the amount of the additional operating reserve, which is required for ensuring a reliable power system operation.

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## PhD Degrees Completed

## Development of Prognostics and Health Management Methods for Engineering Systems Operating in Evolving Environments


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Prognostics and Health Management (PHM) is a field of research and application aiming at detecting the degradation of engineering components, diagnosing the type of faults, predicting the failure time and proactively managing their failures. This PhD work addresses the problem of PHM in an Evolving

Environment (EE) characterized by continuous or periodic modifications of the working conditions. The main difficulty in this context is that the information used to develop the PHM model are usually collected in a limited set of working conditions, not sufficiently representing all the possible conditions that may be experienced by the components during their lives. Thus, the general objective of this thesis is to develop an integrated framework for PHM in EE, which is capable of 1) extracting and selecting the features to be used by the PHM models; 2) detecting the occurrence of modifications (drifts) in the working conditions, and, then, adapting the PHM models to the EE; 3) assessing the performance of the developed PHM models in EE.

The feature extraction and selection problem has been addressed by developing a novel semi-supervised approach whose originality is the combined use of both labeled and unlabeled data. Labeled data containing historical examples of signal values and the corresponding fault classes, collected when the engineering system was operating in a limited set of working conditions, and unlabeled data containing only signal measurements collected in an EE. Wavelet transforms and statistical indicators are used to extract features from the non-stationary measured signals, then, the feature set to be used for fault diagnostics in an EE is selected based on three indicators: 1) the classification accuracy and precision of a Support vector Machine (SVM) classifier, computed considering only the available labeled data; 2) the confidence of a SVM classifier trained using the available labeled data and tested on the unlabeled data collected in the EE; 3) the silhouette index of the classes obtained by SVM classifier considering the unlabeled data. Finally, a sparse Borda Count method is used to perform a multi-objective ranking of all the feature sets and, thus, to identify the one with the most satisfactory trade-off among the three indicators.

With respect to 2), an $\alpha$ surface reconstruction method is developed to detect the occurrence of drifts in the working conditions. Then, once a drift is detected, the diagnostic model is updated by using an approach based on the COMPacted Object Sample Extraction (COMPOSE) algorithm, which is firstly developed in the domain of stream data learning and is modified in this PhD work to fulfil the requirements of fault diagnostics. The improved COMPOSE algorithm allows identifying when it is really necessary to update the classification model due to the presence of a concept drift. A second novelty is an automatic procedure for setting the internal parameters of COMPOSE, in such a way that the size of the training set remains stable.

For the prognostics, a Particle Filter-Based approach has been developed for estimating the unknown effects of the working condition on the physics-based degradation model, and, simultaneously, predicting the Remaining Useful Life (RUL) of the engineering systems. The traditional particle filter is improved by using an Optimized Tuning Kernel Smoothing method, which is capable to overcome the problem of particle impoverishment and maintain the robustness of the degradation state estimation and RUL prediction.

Finally, a method for online assessing the performance of the RUL predictions has been developed to inform the maintenance decision makers on how confident they can be about the obtained prognostic results. This method requires the availability of i) signal measurement collected from the onset of the degradation trajectory until the present time on the degrading engineering system of interest and ii) a generic model-based prognostic approach based on the use of a Bayesian filter. The basic idea behind the on-line performance assessment method is to verify whether the predictions of the degradation state provided in the past have been accurate and precise. In particular, we consider past predictions of the degradation state on time horizons similar to the RUL predicted by the prognostic model at the present time, and we verify the performance of the RUL predictions performed in the past (from the beginning of component life to the present time).

*Figure 1* shows an overview of the developed approaches and the methods on which they are based. Notice that both model-based PHM methods (Particle Filter, Kernel Smoothing, and Monte Carlo Simulation), and data-driven PHM approaches (Wavelet Transform, Statistical indicators, Support Vector Machine, $\alpha$ surface reconstruction and COMPOSE) have been employed. The choice on the type of approach is motivated by the information available to deal with the problem.

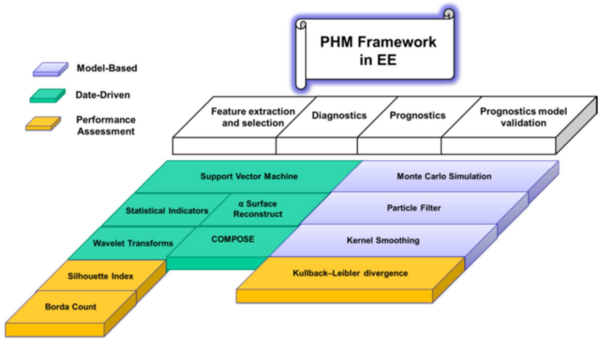


*Figure 1 - Methods applied in this PhD work*

Different PHM applications have been considered to verify the proposed approaches: diagnosis of ball bearing defects and RUL prediction of Li-on batteries, turbine blades in energy production plants and aluminum electrolytic capacitor in fully electrical vehicles. The applications show that in case of modifications of the working conditions, namely in the presence of EE, the proposed PHM methods allow obtaining more accurate and precise diagnostics and prognostics results than the conventional PHM approaches.

# Reliability Modelling of Railway Track Geometry

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A safe, effective and efficient railway is key to modern day transport and mobility solutions. One of the main parameters to assure railway safety and comfortable railway service is to maintain high quality of track geometry. Track geometry can be defined as the deviation of track position from its design geometry in horizontal, vertical and longitudinal directions. It is an important aspect of railway construction which is often used as the main criteria for maintenance and renewal decision making. Poor quality of track geometry not only may result in safety problems, speed reduction, traffic disruption, greater maintenance cost but also affects the degradation of other track components.

The degradation of track quality (*Q(t)*) is a complex phenomenon which occurs from vertical plastic strains due to the influence of dynamic loads. It is normally calculated as a function of traffic in mm/Million Gross Tons (MGT), or time in mm/year. Isolated defects and a standard deviation over specified track length are two main indicators used to describe track geometry quality. In addition, three limits, which are used for maintenance decision making, are Alert Limit (AL), Intervention Limit (IL) and Immediate Action Limit (IAL). *Figure 2* illustrates a plot of longitudinal level (vertical deviation) over a 200 metre straight track at a specific time instant. The fault limits AL and IL are also shown in the figure.

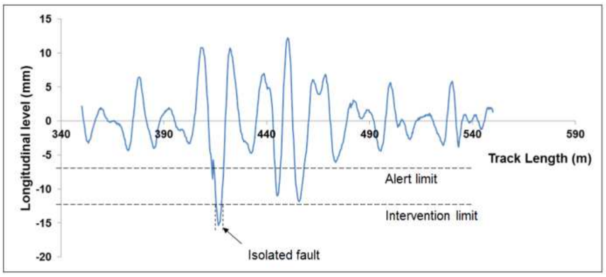


*Figure 2 - Deviations in the longitudinal level over 200 metres of track*

Tamping is the maintenance action performed for restoring the track quality and rectifying the isolated defects. However, tamping cannot recover the geometry quality to an as good as new state. Figure 3 shows the effect of tamping on recovering longitudinal level condition over 100 metre track segment.

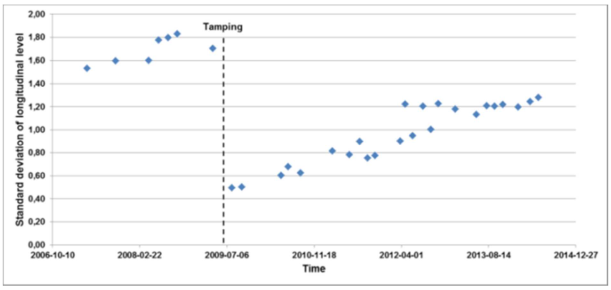


*Figure 3 - Tamping effect on track quality*

Tamping can be performed as either a preventive maintenance (PM) action or a corrective maintenance (CM) action. In this study, tamping, which is performed to restore track quality (standard deviation of geometry parameters), is considered as a preventive maintenance, while tamping to remove isolated defects is considered as a corrective action.

## 1. Reliability model

The objective of modelling is to assess and model the time between two successive maintenance actions (cycle length). *Figure 4* provides schematic description of PM and CM tamping events.

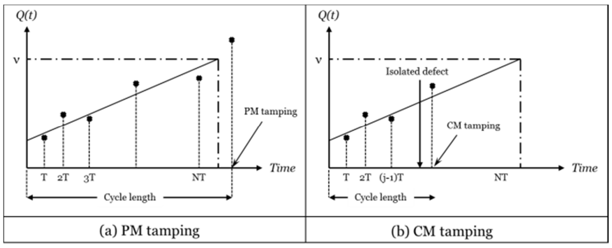


*Figure 4 - Preventive and corrective tamping*

The figure indicates that the track geometry is inspected periodically with the time between inspections given by *T*. The first inspection after *Q(t)* crosses the maintenance limit $\upsilon$ results in a (PM) tamping. Should the fault occur before *Q(t)* crosses the limit ($\upsilon$) then it is detected at the first inspection after the occurrence resulting in a CM tamping. Taking this into account, it is required to model the occurrence of both types of failure modes (high standard deviation and isolated defects) to be able to assess the expected cycle length.

### 1.1 Track quality degradation

Several models have been developed to model the degradation behaviour. The simplest one is the linear model, which assumes that the degradation has a linear trend over time or MGT between two maintenance actions. The degradation function is given by:

$$Q(t) = Q_0 + Bt$$

Where $Q_0$ is the initial track quality (quality after tamping), and $B$ is the degradation rate. Considering different track segments with dissimilar degradation rates, these parameters can be modelled as random variables unknown prior to tamping. By assuming that the parameters $Q_0$ and $B$ are both normally distributed random variables, the density functions for these parameters are as follows:

$$g_1(q) = \frac{e^{-\{(q-\mu_q)/\sigma_q\}^2/2}}{\sqrt{2\pi}\sigma_q}$$

$$g_1(b) = \frac{e^{-\{(b-\mu_b)/\sigma_b\}^2/2}}{\sqrt{2\pi}\sigma_b}$$

**1.2 Occurrence of isolated defects**

The occurrence of isolated defects can be considered as a random event, which does not follow the normal degradation trend. Taking this into account, the probability ($\rho_1$) that an isolated defect occurs in an inspection interval ($T$) can be estimated by:

$$\rho_1 = 1 - e^{-\lambda T}$$

Where $\lambda$ is the hazard rate. The probability no isolated fault occurs is $\rho_0 = 1 - \rho_1$. The estimates of $\rho_1$ and $\lambda$ can be obtained by:

$$\hat{\rho}_1 = \frac{n_1}{n_0 + n_1}$$

$$\hat{\lambda} = \frac{1}{T}\ln\{(n_0 + n_1)/n_0\}$$

Where $n_0$ denotes the number of cycles (time between tamping actions) with no isolated defect and $n_1$ indicates the number of cycles with detected isolated faults.

**2. Conditional Approach**

By conditioning on $Q_0=q$ and $B=b$, the conditional approach can be used. $\tilde{N}_{|q,b}$ is defined as the number of inspections before the degradation crosses the maintenance limit and it can be obtained by:

$$\tilde{N}_{|q,b} = \lceil (\upsilon - q)/bT \rceil$$

$\tilde{L}_{|q,b}$ is defined as the cycle length conditional on $Q_0=q$ and $B=b$. Considering this, the expected value of $\tilde{L}_{|q,b}$ is given by:

$$E[\tilde{L}_{|q,b}] = T\sum_{j=1}^{\tilde{N}_{|q,b}} j\rho_0^{j-1}\rho_1 + T[\tilde{N}_{|q,b} + 1]\left[1 - \frac{\rho_1(1-\rho_0^{\tilde{N}_{|q,b}})}{(1-\rho_0)}\right]$$

On removing the condition, the expected value of cycle length can be obtained by:

$$ECL = \underset{q,b}{E}\, E[\tilde{L}_{|q,b}] = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} E[\tilde{L}_{|q,b}]g_1(q)g_2(b)dqdb$$

**3. Conclusion**

This study proposed an approach to estimate and model the cycle length between two successive maintenance events. The result can be used in a maintenance optimisation process to specify cost-effective maintenance thresholds.

**4. Reference**

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# Past Safety and Reliability Events

## 1st International Computational Reliability Engineering (CRE) Symposium

Düsseldorf, Germany
22nd-23rd October 2015

The first "Computational Reliability Engineering in Product Development and Manufacturing" symposium was held on 22nd and 23rd of October 2015 in Düsseldorf (Germany). The initiative was taken by Prof. Dr.-Ing. Stefan Bracke and his scientific stuff (Annika Müller and Marcin Hinz) - all Chair of Safety Engineering and Risk Management (University of Wuppertal, Germany). During the symposium all invited guests from the academic world and the industry broached the issue of two main topics: future trends and challenges in reliability and risk analysis in development and manufacturing of technical complex products (e.g. automobile industry, tool manufacturing, system engineering) as well as the potentials of an international "Computational Reliability Engineering" master study course.

The goal of the symposium was the exchange of knowledge and experiences between the participants. The research community was represented by Meiji University (Tokyo, Japan), Eskisehir University (Turkey), University of Liverpool (United Kingdom), University of Paderborn (Germany), University of Applied Sciences Cologne (Germany) and University of Wuppertal (Germany). Furthermore, the representatives of the following enterprises were attending the symposium: Siemens AG (Germany), Melitta Europa GmbH & Co. KG (Germany), Robert Bosch GmbH (Germany) and Valeo S.A. (France). ReliaSoft (USA, Poland) and BABTEC (Germany) introduced their computer aided techniques for the reliability and risk analysis.

During the two days of symposium, the participants had the opportunity to attend the interactive presentations and discussions regarding the future trends of technical reliable products and manufacturing processes within the phases of the product development process (design, development and manufacturing) and the product usage phase. An example of a future trend concerning product development is the increasing necessity of testing on the system level instead of on the component level. For this purpose both experimental and theoretical research needs to be done. Due to the manufacturing phase, the main issues are the uncertainties in the environmental conditions and the optimal integration of employees in assembly lines with regard to learning curves and increasing product diversity. A very important requirement to predict the reliability and to analyse the risk of a product is the proper structure of the data base as well as the proper handling of the big data. According to Professor Stefan Bracke, “the experts agreed about the high number of challenges in the field of reliability within the whole product life cycle caused by the exponential increase of complexity and functionality of products, which leads automatically to big data sources”.

In addition to the international research cooperation, the experts discussed the cooperation possibilities in a new, international master study course “Computational Reliability Engineering” in Wuppertal, Germany. The participants agreed about the importance of a study course in English on the master level to educate professional reliability engineers. On the basis of a curriculum proposal, the course shall be divided into the compulsory and selective courses, which will give the opportunity of various specialisations within the reliability engineering.

All participants decided to continue the symposium annually. The second CRE-Symposium will be at 27.-28. October 2016 in Dresden, Germany. The organisation team will be the University of Wuppertal (Germany, Prof. Stefan Bracke) in collaboration with BABTEC (Germany, Dresden, Peter Mörs) and the MEIJI University Tokyo (Japan, Prof. Masato Inoue). The main topic will be high precision manufacturing of complex products and the analysis of big data out of the product usage phase with regard to the technical reliability.

The organisers thank the official supporters: ESRA (Netherlands), MEIJI University (Japan), University of Wuppertal (Germany) and IAP GmbH (Germany) for the great opportunity to create the CRE platform for international reliability experts.

For further questions please contact:

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# Calendar of Safety and Reliability Events

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## 35th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2016) Symposium on Structures, Safety and Reliability

Busan, South Korea

19th-24th June 2016

Since 2003, the OMAE conference has more than tripled in size, with over 1,000 participants at OMAE 2015 in St. John’s, Canada. We expect to set a new OMAE attendance record in Busan with the goal of exceeding 1,500 participants.

The annual OMAE conference is an international assembly of engineers, researchers, technical specialists and students in the fields of ocean, offshore and arctic engineering. It is an opportunity to meet and present advances in technology and its scientific support, exchange ideas and experiences whilst promoting technological progress and its application in industry and promote international cooperation in ocean, offshore and arctic engineering.

Call for papers - Authors should submit a title/abstract to begin the paper submission process. Prior to the date noted below, authors should then submit full-length manuscripts for peer review. Draft manuscripts and final-paper submissions must conform to ASME publication guidelines.

Important dates:

- December 14, 2015 – Deadline for Abstract Submission
- January 4, 2016 – Full-Length Draft Paper Due
- February 22, 2016 – Notification of Acceptance/Rejection
- March 21, 2016 – Final Paper Due

Conference Website: **http://www.omae2016.com**

## 6th International Conference on Accelerated Life Testing and Degradation models (ALT 2016)

Troyes, France

22th-24th June 2016

ALT’2016 is the 6th international conference concerned with the latest scientific results and applications in reliability testing and analysis. The aim of the conference is to bring researchers and practitioners from universities, institutions and industries, together to present and discuss innovative methodologies and practical applications in the reliability field: assessment, modeling, testing, analysis, design and optimization. Theoretical issues and applied case studies will range from academic considerations to industrial, medical, and social applications. There will be invited talks, plenary and parallel sessions. Accepted papers will be published in the conference proceedings.

All the previous editions were in France: Angers (2006), Bordeaux (2008), Clermont-Ferrand (2010), Rennes (2012) and Pau (2014).

Based on the previous editions, around 5 half-days are planned for the talks. Each day will start and close by plenary invited talks. Between, there will be an alternate of parallel sessions and plenary invited talks.

Thus, the program should include around 40 talks set as follows:
- 11 plenary invited talks (45 minutes);
- around 30 short talks (20 minutes) in the parallel sessions.

Registration fees are fixed to 300 euros, except for PhD students (100 euros). The planned budget is based on the registration of 30 participants at the full rate and 15 at the reduced rate. For the invited speakers, registration fees and hotels will be covered, and apart of the trip (up to 550 euros for now). The participation of young researchers/professors and PhD students will be promoted through low registration fees. The total number of participants is expected to be around 60 and 70.

Important dates:
- January 31, 2016 – One page abstract submission deadline
- March 15, 2016 – Notification acceptance/rejection
- May 15, 2016 – Full paper submission deadline

Conference Website: **http://alt2016.sciencesconf.org**

## 2016 International Conference on Quality, Reliability, Risk, Maintenance and Safety Engineering (QR2MSE 2016)
Jiuzhaigou, Sichuan, China
25th-28th July 2016

QR2MSE 2016 & WCEAM 2016 is an international forum for exchange of innovative ideas, cutting-edge research results, and applications of asset management, reliability and quality tools in design, manufacturing, and operation and maintenance of engineering systems. Papers dealing with case studies, reliability data generation, experimental results, best design practice, and effective asset management solutions are of particular interest. All papers accepted will be included in the conference proceedings. Selected peer reviewed papers will be published in Springer's ebook proceedings and international journals indexed by Thomson Reuters Web of Science (SCI) or Engineering Village (EI Compendex).

Topics of Interests:
- Strategic asset management
- Prognostics and health management
- Asset fleet management
- Condition based maintenance
- Quality engineering
- Quality assurance and cost issues
- Experimental design for quality control
- Total quality management techniques
- Reliability theory and application
- Product reliability and safety evaluation
- Reliability testing and statistics
- Structural reliability
- Equipment management and maintenance
- e-Maintenance
- Maintenance support modeling and simulation
- Reliability centered maintenance
- Novel technologies for maintenance: robotics, virtual reality and additive manufacturing
- Life cycle management and services
- Systems integrity management
- Software reliability and testing
- Reliability tools for product development
- Risk management
- Physics of Failure
- Inspection
- Advanced sensor technologies
- Condition monitoring, diagnostics and prognostics
- System health and analytics
- Contractor logistics theory and practice
- Optimal design
- Multidisciplinary design optimization
- Human and organisational factors
- Applications of industrial internet
- Supply chain management
- Standardisation
- Information management

Submission of papers - Extended abstract or full papers should be submitted electronically in MS-Word via icqrms@uestc.edu.cn by March 10, 2016. Authors' names, affiliations, and contact information must be included in submission.

Important dates:
- Mar 10, 2016 – Full Paper Submission Deadline
- Apr 10, 2016 – Full Paper Acceptance Notification
- Apr 30, 2016 – Camera Ready Papers Due

Conference website: **http://www.qr2mse.org**

## The 35th International Conference on Computer Safety, Reliability and Security (SafeComp 2016)
Trondheim, Norway
20th-23th September 2016

Since it was established in 1979 by the European Workshop on Industrial Computer Systems, Technical Committee 7 on Reliability, Safety and Security (EWICS TC7), SAFECOMP has contributed to the progress of the state-of-the-art in dependable application of computers in safety-related and safety-critical systems. SAFECOMP is an annual event covering the state-of-the-art, experience and new trends in the areas of safety, security and reliability of critical computer applications.
SAFECOMP provides ample opportunity to exchange insights and experience on emerging methods, approaches and practical solutions. It is a single track conference without parallel sessions, allowing easy networking.

The conference covers all aspects related to the development, assessment, operation and maintenance of safety-related and safety-critical computer systems.

Important dates:
- February 1, 2016 – Workshop proposal submission
- March 4, 2016 – Full paper submission
- May 6, 2016 – Notification of acceptance
- June 13, 2016 – Fast Abstract submission
- September 20, 2016 – Workshops
- September 21-23, 2016 – Conference

Conference website: **http://ntnu.edu/safecomp2016**

## 35th Symposium on Reliable Distributed Systems (SRDS)
Budapest, Hungary
26th-29th September 2016

The 35th Symposium on Reliable Distributed Systems (SRDS 2016) plans to run pre-conference workshops (half-day or full-day) on September 26th, 2016, similarly to what happened in previous editions of the conference. Researchers interested in organizing a workshop on topics related to reliable distributed systems are invited to submit workshop proposals.

The proposals shall be submitted via e-mail to the SRDS 2016 Workshop Co-chairs:
· Sanjay Madria, Missouri University of Science and Technology, USA - madrias@mst.edu
· Miguel Correia, INESC-ID, Instituto Superior Técnico, Portugal – miguel.p.correia@tecnico.ulisboa.pt

Important dates:
- February 28, 2016 – Workshop proposals
- March 4, 2016 – Notification of acceptance
- September 26, 2016 – Workshop day

Conference website: **http://srds2016.inf.mit.bme.hu**

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# ESRA Information

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### 1. ESRA Membership

#### 1.1 National Chapters
- French Chapter
- German Chapter
- Italian Chapter
- Polish Chapter
- Portuguese Chapter
- Spanish Chapter
- UK Chapter

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

#### 1.3 Companies
- TAMROCK Voest Alpine, Austria
- IDA Kobenhavn, Denmark
- VTT Industrial Systems, Finland
- Bureau Veritas, France
- INRS, France
- Total, France
- Commissariat á l'Energie Atomique, France
- DNV, France
- Eurocopter Deutschland GMbH, Germany
- GRS, Germany
- SICURO, Greece
- VEIKI Inst. Electric Power Res. Co., Hungary
- Autostrade, S.p.A, Italy
- D'Appolonia, S.p.A, Italy
- IB Informatica, Italy
- RINA, Italy
- TECSA, SpA, Italy
- TNO Defence Research, The Netherlands
- Dovre Safetec Nordic AS, Norway
- PRIO, Norway
- SINTEF Industrial Management, Norway
- Central Mining Institute, Poland
- Adubos de Portugal, Portugal
- Transgás - Sociedade Portuguesa de Gás Natural, Portugal
- Cia. Portuguesa de Producção Electrica, Portugal
- Siemens SA Power, Portugal
- ESM Res. Inst. Safety & Human Factors, Spain
- IDEKO Technology Centre, Spain
- TECNUN, Spain
- TEKNIKER, Spain
- CSIC, Spain
- HSE - Health & Safety Executive, UK
- Atkins Rails, UK
- W.S. Atkins, UK
- Railway Safety, UK
- Vega Systems, UK

#### 1.4 Educational and Research Institutions
- University of Innsbruck, Austria
- University of Natural Resources & Applied Life Sciences, Austria
- AIT Austrian Institute of Techn. GmbH, Austria
- Université Libre de Bruxelles, Belgium
- University of Mining and Geology, Bulgaria
- Czech Technical Univ. in Prague, Czech Republic
- Technical University of Ostrava, Czech Republic
- University of Defence, Czech Republic
- Tallin Technical University, Estonia
- Helsinki University of Technology, Finland
- École de Mines de Nantes, France
- Université Henri Poincaré (UHP), France

- Laboratoire d'Analyse et d'Architecture des Systèmes (LAAS), France
- Université de Bordeaux, France
- Université de Technologie de Troyes, France
- Université de Marne-la-Vallée, France
- INERIS, France
- Fern University, Germany
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- Technische Universität Wuppertal, Germany
- University of Kassel, Germany
- TU Braunschweig, Germany
- Institute of Nuclear Technology Radiation Protection, Greece
- University of the Aegean, Greece
- Universita di Bologna (DICMA), Italy
- Politecnico di Milano, Italy
- Politecnico di Torino, Italy
- Universita Degli Studi di Pavia, Italy
- Universita Degli Studi di Pisa, Italy
- Technical University of Delft, The Netherlands
- Institute for Energy Technology, Norway
- Norwegian Univ. Science & Technology, Norway
- University of Stavanger, Norway
- Technical University of Gdansk, Poland
- Gdynia Maritime Academy, Poland
- Institute of Fundamental Techn. Research, Poland
- Technical University of Wroclaw, Poland
- Instituto Superior Técnico, Portugal
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- Universidade de Minho, Portugal
- Universidade do Porto, Portugal
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- Slovak Academy of Sciences, Slovakia
- University of Trencin, Slovakia
- Institute "Jozef Stefan", Slovenia
- Asociación Española para la Calidad, Spain
- PMM Institute for Learning, Spain
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- Universidad Politecnica de Valencia, Spain
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- University of Castilla-La Mancha, Spain
- LuleåUniversity, Sweden
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- Institut f. Energietechnik (ETH), Switzerland
- Paul Scherrer Institut, Switzerland
- City University London, UK
- Liverpool John Moores University, UK
- University of Aberdeen, UK
- University of Bradford, UK
- University of Salford, UK
- University of Strathclyde, Scotland, UK

### 1.5 Associate Members

- Federal University of Pernambuco, Brazil
- Fluminense Federal University, Brazil
- Pontifícia Universidade Católica, Brazil
- European Commission - DR TREN (Transport and Energy), in Luxembourg
- Vestel Electronics Co., Turkey

## 2. ESRA Officers

### Chairman

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

### Vice-Chairman

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Technical University of Ostrava, Czech Republic

### General Secretary

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Enrico Zio (enrico.zio@polimi.it)
Politecnico di Milano, Italy

### Chairmen of the Standing Committees

Antoine Grall, University of Technology of Troyes, France
C. Guedes Soares, Instituto Superior Técnico, Portugal

## 3. Standing Committees

### 3.1 Conference Standing Committee

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

### 3.2 Publications Standing Committee

Chairman: C. Guedes Soares, Instituto Sup. Técnico, Portugal
This committee has the responsibility of interfacing with Publishers for the publication of Conference and Workshop proceedings, of interfacing with Reliability Engineering and System Safety, the ESRA Technical Journal, and of producing the ESRA Newsletter.

## 4. Technical Committees

### Technological Sectors

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

**4.2 Critical Infrastructures**
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E-mail: Giovanni.Sansavini@mail.polimi.it

**4.3 Energy**
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E-mail: Kurt.Petersen@lucram.lu.se

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**4.6 Safety in the Chemical Industry**
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**Methodologies**

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**4.11 Prognostics & System Health Management**
Chairman:Piero Baraldi, Italy
E-mail: Piero.baraldi@polimi.it

**4.12 Foundational Issues in Risk Assessment & Management**
Chairmen: Terje Aven, Norway & Enrico Zio, Italy
E-mail: terje.aven@uis.no; enrico.zio@polimi.it

**4.13 Human Factors and Human Reliability**
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**4.14 Maintenance Modelling and Applications**
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**4.15 Mathematical Methods in Reliability and Safety**
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**4.20 Structural Reliability**
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**4.21 Occupational Safety**
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ESRA is a non-profit international organization for the advance and application of safety and reliability technology in all areas of human endeavour. It is an “umbrella” organization with a membership consisting of national societies, industrial organizations and higher education institutions. The common interest is safety and reliability.
For more information about ESRA, visit our web page at http://www.esrahomepage.org.
For application for membership of ESRA, please contact the general secretary Coen van Gulijk E-mail: c.vangulijk@hud.ac.uk.
Please submit information to the ESRA Newsletter to any member of the Editorial Board: