



HAL
open science

Correlation analysis in a system subject to a Wiener bivariate degradation model and imperfect repairs

Lucia Bautista, Christophe Bérenguer, Inmaculada T. Castro, Olivier Gaudoin, Laurent Doyen

► **To cite this version:**

Lucia Bautista, Christophe Bérenguer, Inmaculada T. Castro, Olivier Gaudoin, Laurent Doyen. Correlation analysis in a system subject to a Wiener bivariate degradation model and imperfect repairs. MMR 2023 - 12th International Conference On Mathematical Methods In Reliability, Universidad de Murcia, May 2023, Murcia, Spain. pp.55-56. hal-04247090

HAL Id: hal-04247090

<https://hal.science/hal-04247090v1>

Submitted on 17 Oct 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

Correlation analysis in a system subject to a Wiener bivariate degradation model and imperfect repairs

Lucía Bautista¹, Christophe Bérenguer², I.T. Castro¹, Laurent Doyen³, Olivier Gaudoin³.

¹ Universidad de Extremadura, Cáceres, Spain.

² GIPSA-Lab, Université Grenoble Alpes, Grenoble INP, Grenoble, France.

³ Laboratoire Jean Kuntzmann, Université Grenoble-Alpes, Grenoble, France.

Several mathematical models have been proposed in the recent literature to analyze multiple dependent degradation processes, such as those based on copulas, multivariate joint distributions or degradation rate interaction methods. However, it is sometimes difficult to construct an accurate copula, so multivariate distributions easily extend results and properties from univariate ones. This work focuses on the correlation analysis of a system subject to a bivariate degradation model. Two dependent degradation processes are created from three independent degradation processes using the so-called trivariate reduction method. These correlated processes represent a system consisting of two dependent components that share a common noise. Specifically, the Wiener process is used to model this bivariate degradation.

Imperfect repairs are periodically performed, and the overall system deterioration is reduced in a fixed percentage given by the repair efficiency parameter. This maintenance model is known as Arithmetic Reduction of Degradation (ARD). Under these assumptions, the Pearson correlation coefficient is obtained at each repair for two random paths of the bivariate Wiener process considering linear and non-linear drifts. Different properties of the monotony of this correlation coefficient are evaluated.

Keywords: *bivariate degradation, Wiener process, Pearson correlation coefficient, imperfect repairs.*

Acknowledgements: This work is supported by the French National Research Agency in the framework of the «France 2030» program (ANR-15-IDEX-0002), the LabEx PERSYVAL-Lab (ANR-11-LABX-0025-01), Junta de Extremadura (Project GR21057) and European Union (European Regional Development Funds).

References

- [1] Doyen L., Gaudoin O. (2004). Classes of imperfect repair models based on reduction of failure intensity or virtual age. *Reliability Engineering & System Safety*, 84(1), 45-56.
- [2] Sacerdote L., Tamborrino M., Zucca C. (2016). First passage times of two-dimensional correlated processes: Analytical results for the Wiener process and a numerical method for diffusion processes. *Journal of Computational and Applied Mathematics*, 296, 275-292.

[3] Yan B., Wang H., Ma X. (2022). Correlation-driven multivariate degradation modeling and RUL prediction based on Wiener process model. *Quality and Reliability Engineering International*, 1-27.

[4] Wang X., Gaudoin O., Doyen L., Bérenguer C., Xie M. (2021). Modeling multivariate degradation processes with time-variant covariates and imperfect maintenance effects. *Applied Stochastic Models in Business and Industry*, 37(3), 592-611.