



**HAL**  
open science

# Multi-Objective and Non-deterministic Optimization of Vehicle Restraint Systems

Gengjian Qian, Michel Massenzio, Denis Brizard, Mohamed Ichchou

► **To cite this version:**

Gengjian Qian, Michel Massenzio, Denis Brizard, Mohamed Ichchou. Multi-Objective and Non-deterministic Optimization of Vehicle Restraint Systems. CFM 2017 - 23ème Congrès Français de Mécanique, Aug 2017, Lille, France. hal-03465365

**HAL Id: hal-03465365**

**<https://hal.science/hal-03465365>**

Submitted on 3 Dec 2021

**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.

# Multi-Objective and Non-deterministic Optimization of Vehicle Restraint Systems

Gengjian Qian<sup>1</sup>, Michel Massenzio<sup>1,a</sup>, Denis Brizard<sup>1</sup>, Mohamed Ichchou<sup>2</sup>

<sup>1</sup> Univ Lyon, Université Claude Bernard Lyon 1, IFSTTAR, LBMC UMR\_T9406, F69622, Lyon, France

<sup>2</sup> Laboratoire de Tribologie et Dynamique des Systèmes, École Centrale de Lyon, 69134 Ecully, France

**Abstract** – Procedures for Multi-Objective Non-deterministic Optimization (MONO) of complex engineering systems are discussed and the optimization of a Vehicle Restraint System (VRS) is realized with Finite Element (FE) simulation. In the previous studies: performances of a VRS have been tested by crashing with a vehicle and the FE model of the crash test has been created; the critical factors whose uncertainties contribute the most to the performance uncertainties of the VRS have been identified through sensitivity analysis. In this article: the inputs' space of design variables and outputs uncertainties are studied to define design intervals and the constraints of optimization; Kriging interpolation method is used to create the surrogate model and the precision of the surrogate model is estimated with a new approach; uncertainties of the critical factors are considered and the VRS is optimized through MONO with the surrogate model; performances of the optimized device are evaluated under different crash conditions.

**Key words:** crash simulation / multi-objective optimization / robust design / uncertainty analysis / sensitivity analysis / Vehicle Restraint Systems