Paper ID: 68485
oral
student

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Specialized Technologies, Including Nanotechnology (8)

Author: Ms. Corinna Cerini
University of Auckland, New Zealand

Prof. Guglielmo S Aglietti
University of Auckland, New Zealand

# ESTIMATION OF A CRAIG-BAMPTON EQUIVALENT MODEL USING A HYBRID PARTICLE SWARM OPTIMIZATION FOR DCLA PURPOSES

**Abstract**

It is common practice in industry to deliver a Craig-Bampton (CB) reduced version of the spacecraft (S/C) Finite Element Model (FEM) to the launch authorities to perform the Dynamic Coupled Load Analysis (DCLA). During the DCLA, the FEM of the S/C is coupled with the FEM of the Launch Vehicle (LV) to predict the responses caused by the vibration environment produced during the launch phases (e.g., lift-off, engine start-up, etc.). DCLAs must be accurate, as it is the base to generate the final hardware test specifications, without which there is no guarantee that the S/C will survive the launch loads. Therefore, the DCLA is a crucial phase in the design and verification process of a S/C and its FEM is a key element. Before being CB-reduced, the FEM needs to be correlated and validated against physical test results to guarantee its capability to reproduce the actual behaviour of the physical hardware, which is essential to perform a meaningful DCLA. The correlation process might require a reduction of the number of numerical Degrees of Freedom (DoF) to match the test DoFs, corresponding to the sensor locations and measurement directions. If the discrepancies between numerical predictions and physical test are above set thresholds, the FEM needs to be updated/tuned until a satisfactory agreement is reached. Given the complexity and size of the FEM, the entire process can be very demanding. In this paper, an alternative to the mathematical models usually used in the DCLA is investigated. The main idea is to synthesize a Craig-Bampton equivalent model directly from response data of a vibration test experiment. The system identification problem is solved using a Particle Swarm Optimization (PSO) algorithm, tailored specifically for this type of application. Operators from different evolutionary algorithms (e.g., Genetic Algorithm) are used to improve the solution, as well as a local search method to refine the result. The proposed method is numerically validated on several case studies, representative of simplified S/C structures.