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APPLICATION OF METAMODEL-BASED ROBUST DESIGN OPTIMIZATION TO INDUSTRIAL PROBLEMS

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ABSTRACT

The future of industrial design optimization is robust design optimization whereby a design is optimized for real world conditions and not just for one particular set of idealized nominal conditions. This paper introduces a practical process used for simultaneous optimization of the robustness of a design and its performance. This work is intended to demonstrate the use of metamodels built by the Moving Least Squares Method (MLSM) [1,2] (implemented in Altair HyperStudy [3]) as a CAE enabler to facilitate robust design.

Over the last decade major industries in general, and automotive industry in particular, have been lead into the philosophy of manufacturing quality to six sigma. This paper presents an applications of designing systems to given sigma level of quality thus ensuring that designs (or their numerical models) perform within specified limits of statistical variation.

Typically, in CAE the analysis of a highly non-linear system (e.g. as related to crashworthiness assessment in automotive industry) will require simulation times ranging from one hour to a day (or even days), making the use of full analyses for iterative design optimization computationally prohibitive, particularly when robustness assessment requires hundreds or thousands of calls for analysis within a Monte Carlo simulation. To overcome these problems a response approximation or metamodel is required. This is done using the information generated by an advanced design of experiments (e.g. an optimum Latin hypercube design [4,5]) together with an appropriate metamodelling algorithm, such as MLSM. The metamodel gives the value of a key output response in the design space (e.g. peak deceleration in case of a crashworthiness problem) as a function of the design variables as well as of uncontrollable variables. Many thousands of simulations on a metamodel can be run in

a few minutes.

Performing deterministic optimization followed by robustness assessments [6] is becoming an established part of the design process. However, applications of simultaneous robustness and performance optimization are still very limited in industry, hence it was the focus of this study.

The methodology for generating optimal robust designs that has been developed in this work is illustrated by two examples. The first is a composite cantilever beam, on which the methodology was developed and tested, and the second is an automotive example of the design of a knee bolster system.

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